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Efficiency and productivity in Sri Lanka's banking sector: Evidence from the post-conflict era

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BSc (Hons)(Colombo) MA (Colombo) MSc (UQ)

This thesis is submitted to the University of Wollongong, in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy

2016

CERTIFICATION

I, Bolanda Hewa Thilakaweera, declare that this thesis, submitted in partial fulfilment of the requirement for the award of Doctor of Philosophy, in the School of Accounting, Economics and Finance, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Bolanda Hewa Thilakaweera

ABSTRACT

After the end of the 26-year armed conflict between the Sri Lankan government and the ethnic Tamil rebels in 2009, Sri Lanka experienced a favourable macroeconomic environment with an improvement in security conditions, resettlement and the revival of economic activities in the Northern and Eastern regions of the country. The banking sector also recorded significant expansion with respect to the volume of transactions as well as geographical dispersion of banking services during this period, stimulated by the overall economic growth. The aim of this thesis is to conduct a thorough analysis of the technical efficiency and productivity of the Sri Lankan banking sector encompassing the period of post-conflict economic expansion beginning in 2009. To achieve this aim the thesis focuses on five main areas. First, it compares banking sector efficiency in the periods immediately before and after the end of the armed conflict in Sri Lanka. Second, it compares the efficiency of three mutually exclusive bank groups, namely foreign commercial banks, domestic commercial banks and domestic specialised banks. Third, it evaluates the potential determinants of banking sector efficiency, including the contribution of branch network expansion and the geographical dispersion of branches. Fourth, it evaluates productivity changes across the two periods (before and after the end of the armed conflict) for the three abovementioned banking groups. Fifth, it analyses disparities in banking sector efficiency across the nine regions of Sri Lanka, and the contribution of socio-economic factors to their efficiency.

Deviating from the use of conventional averages of efficiency scores in comparing performance, this study uses aggregate efficiency measures introduced by Färe and Zelenyuk (2003) to compare banking sector performance before and after the end of the

armed conflict, across the different groups of banks and between the nine regions in   Sri Lanka. Further to the aggregate efficiency measures, the Li test, adapted by Simar and Zelenyuk (2006) in the context of the efficiency and meta-technology technique introduced by O'Donnell et al. (2008), are also utilised in this study to compare banking performance before and after the end of the armed conflict and between the different bank groups. The Li test and meta-technology technique are new to the literature on banking efficiency and are ideal methodologies for use in comparing the performances of the banking industry over the time periods highlighted and for comparing the performances of bank groups. The semi-parametric double bootstrap regression analysis employed for evaluating the determinants of banking efficiency at the national level and regional level are also among the latest methods used in the literature. Productivity before and after the end of the armed conflict and across the different groups of banks are measured using the Global Malmquist Index (GMPI). The GMPI enables comprehensive comparisons of banking productivity to be made.

The empirical analysis presented reveals an improvement in the efficiency of the   Sri Lankan banking industry in the post-conflict era compared to the period before the end of the armed conflict with respect to both intermediation services and profit-oriented operations. In line with the findings of the efficiency analysis, the meta-technology analysis also reveals an improvement in the technology set of the banking industry in the favourable economic environment prevailing in the post-conflict era. Productivity of the banks with respect to intermediation services improved during the post-conflict era mainly due to technological improvement, while a marginal increase in productivity was found for profit-oriented operations. In a comparison of the performances of groups of banks, domestic banks recorded higher efficiency in intermediation while foreign banks

outperformed the other bank groups with respect to profit-oriented operations, reflecting their focus on profitability. Foreign banks recorded a higher technology set in both intermediation and profit-oriented operations, confirming the higher technology use by foreign banks as asserted in the mainstream literature. Further, the productivity increase in intermediation was mainly driven by technology changes in domestic bank groups during the post-conflict era in line with improvements in the macroeconomic environment. A semi-parametric truncated regression analysis confirmed the absence of a relationship between expansions in branch networks and the efficiency of the banks, suggesting the possible use of branch expansion as a policy tool to achieve balanced regional growth. Regional level analysis also revealed significantly higher efficiency in bank groups in the Western region when output was measured with respect to the volume of advances and deposits, reflecting higher demand and opportunities for banks in the rich Western region. Further, the study revealed closer correlations between bank efficiency and socio-economic conditions when output was measured in terms of the number of advances and deposits, indicating the importance of socio-economic variables in formulating regional level policies for improving banking sector efficiency.

This study has made four significant contributions to the efficiency and productivity literature. First, it contributes to the literature by assessing bank efficiency and productivity dynamics when a banking sector expands in terms of credit, the number of branches and geographical dispersion during a post-conflict period, with specific reference to the emerging market of Sri Lanka. Second, Simar and Zelenyuk's aggregate efficiency measures have been applied in this study for the first time to compare sectors of the banking industry across two periods of time, thereby providing a comprehensive assessment of the post-conflict performance of the banking sector in Sri Lanka. A new

framework for banking studies to use in assessing industry-level efficiency across two time periods is provided by this methodology, which accounts for bank size when comparing the banking industry over time. Third, this study is among a limited number of studies which explore the expansion-efficiency nexus in the banking sector, particularly in the context of a developing country incorporating growth in branch networks and the geographical dispersion of branches. Fourth, the study also introduces a new approach to compare regional level banking performance by employing an aggregate efficiency technique which is an ideal framework for tracking disparities in regional level banking.

LIST OF CANDIDATURE'S PUBLICATIONS, PRESENTATIONS AND AWARDS

Thilakaweera, B, Harvie, C & Arjomandi, A 2016, 'Branch expansion and banking efficiency in Sri Lanka's post-conflict era', *Journal of Asian Economics,* Vol 47, pp. 45-57.

Thilakaweera, B, Harvie, C & Arjomandi, A 2016, 'Regional determinants of banking efficiency: Evidence from Sri Lanka's post-conflict era', *World Banking and Finance Symposium,* 14-15 December 2016, University of Dubai, Dubai.

Thilakaweera, B, Harvie, C & Arjomandi, A 2016, 'Bank outreach and performance: evidence from banking efficiency in Sri Lanka', *The International Conference of the Association of Korean Economic Studies (AKES) on Korea and the World Economy XV: 'New Economic Paradigm and Sustainable Development',* 5-6 August 2016, Korean Federation of Banks, Seoul, Korea.

Thilakaweera, B, Harvie, C & Arjomandi, A 2016, 'Dispersion of branch networks and banking efficiency: Evidence from Sri Lanka's post-conflict era', *Conference on Applied Financial Modelling*, February 4, 2016, Deakin University, Melbourne Burwood Campus, Australia.

Thilakaweera, B, Harvie, C & Arjomandi, A 2015, 'Bank ownership and efficiency in post-conflict era of Sri Lanka: Evidence from aggregate efficiency technique' *Global Business and Finance Research Conference* 25-27 May 2015, Marriott Hotel, Melbourne, Australia organised by Australian Research Centre for Accounting, Finance and Economics (ARCAFE).

Thilakaweera, B, Harvie, C & Arjomandi, A 2014, 'Bank ownership and efficiency in post-conflict era: Evidence from Sri Lanka', *Informing Science & IT Education Conference (InSITE)* 2014, 30th June to 4th July 2014, University of Wollongong Australia organised by *Informing Science Institute* 131 Brookhill Court, Santa Rosa, California 95409, United States.

Thilakaweera, B, Recipient, Higher Degree Research Student Excellence Award 2015, Faculty of Business, University of Wollongong, Australia.

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LIST OF ABBREVIATIONS

CBC   Ceylon Banking Commission

CBSL   Central Bank of Sri Lanka

CCPI   Colombo Consumer Price Index

CFS   Consumer Finances and Socio-economic Survey

CRS   Constant Returns to Scale

CSE   Colombo Stock Exchange

DCS   Department of Census and Statistics

DEA   Data Envelopment Analysis

DFA   Distribution Free Approach

DFCC   Development Finance Corporation of Ceylon

DMU   Decision Making Unit

EPF   Employees' Provident Fund

ETF   Employees' Trust Fund

EU   European Union

FAH   Free Aggregation Hull

FDH   Free Disposal Hull

FCBU   Foreign Currency Banking Unit

GDP   Gross Domestic Product

GFC   Global Financial Crisis

GMPI   Global Malmquist Productivity Index

HDI   Human Development index

HIES   Household Income and Expenditure Survey

HNB   Hatton National Bank

IBSL   Insurance Board of Sri Lanka

ICSL   Insurance Corporation of Sri Lanka

IMF   International Monetary Fund

LTTE   Liberation Tigers for Tamil Eelam

MPI   Malmquist Productivity Index

MTR   Meta-technology ratio

NIRS   Non Increasing Returns to Scale

NPA	Non Performing Advances
OBL	Oriental Bank Ltd
OMO	Open Market Operations
ROA	Return on Assets
RRDB	Regional Rural Development Banks
SEC	Security Exchange Commission of Sri Lanka
SFA	Stochastic Frontier Analysis
SME	Small and Medium Enterprises
SOE	State-owned Enterprises
SRR	Statutory Reserve Requirements
TFA	Thick Frontier Approach
US	United States of America
VAR	Vector Auto Regressive
VRS	Variable Returns to Scale
WAEMU	West African Economic Monetary Union

Chapter 1   Introduction

1.1   Background of the study

Literature in the area of financial sector development claims that an efficient and developed financial sector fosters efficient resource allocation and hence faster economic development (Goldsmith 1969; Shaw 1973; McKinnon 1974; King & Levine 1993). Levine (2005) describes the role of the financial sector in stimulating an economy as: providing prior information about possible investments and the efficient allocation of capital, monitoring investment, facilitating risk management, trading and diversification of investment, mobilising savings and facilitating the exchange of goods and services. In most countries, the financial sector is dominated by banks due to the underdevelopment of market-based financial institutions. Therefore, policy makers and regulators are always concerned about the efficiency of the banking sector, as inefficiency in this sector can result in resource misallocation across key sectors and firms. This results in poor efficiency and productivity performance among domestic firms and industries that reduces overall economic growth and development. From a social welfare perspective, a "dead weight loss" is generated by the sub-optimal allocation of resources, implying the use of more resources than is technically required to maintain a given level of output.

Developed and developing countries continue to introduce banking sector reforms and regulations aimed at establishing a more sound and efficient banking industry, while maintaining the stability of the financial system in particular, and the stability of their economies as a whole. Banking sector reforms are encouraged by international financial organisation such as the World Bank and the IMF (International Monetary Fund) and banking reforms are at the top of the policy agenda in many developing and emerging

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market economies which have relatively underdeveloped financial sectors (Biagio & Larry 1998). Among the South Asian nations Sri Lanka was the first to engage in extensive liberalisation of its economy, in 1977. This involved the introduction of reforms in the financial sector aimed at achieving higher economic growth. As in most other developing countries the banking sector accounts for 65% of all financial sector assets in Sri Lanka and is the dominant player in the sector. Although the banking sector reforms started in 1977, and although expansion in the banking sector with respect to the number of branches, and credit and transaction volumes subsequently occurred, a free market environment in the banking sector remained limited due to the dominance of state-owned banks and restrictive regulations. By 2002, the market share of the private banks exceeded that of the state-owned banks, indicating the emergence of significant private investment in the banking sector.

Since the early 2000s the banking sector has operated in a more liberalised market environment. The regulator, the Central Bank of Sri Lanka (CBSL), relaxed a number of restrictions on the banking sector while taking prudential measures to promote an efficient, sound and stable banking sector (CBSL 2013b; 2013c). This improved the competitiveness of the banking industry while minimising the asymmetric business environment among state-owned, private and foreign banks. After the end of the armed conflict in 2009, the economy recorded unprecedented economic growth in two consecutive years, despite fragile economic conditions in the world's advanced countries. A positive economic environment, along with reforms introduced in the   post-conflict era, the banking sector further expanded in terms of credit, geographical dispersion and number of branches.

These changes are likely to have exerted a significant impact on banking sector efficiency and productivity in Sri Lanka. However, no study has focused on the performance of the banking sector in Sri Lanka in the period immediately before and after the end of the armed conflict, despite Sri Lanka providing an ideal case study for assessing the impact of post-conflict reforms, geographical expansion and other determinants on banking sector efficiency for an emerging market economy. Therefore, this study provides a comprehensive analysis of banking sector efficiency and productivity in Sri Lanka for the period 2006–2014. The analysis is mainly focused on: changes in banking sector performance immediately before and after the end of the armed conflict in the country, the impact of branch expansion and other determinants on banking performance during the reference period and regional level disparities in banking sector performance in Sri Lanka.

1.2 Research questions

The literature on banking sector intermediation has identified the provision of intermediaries between lenders and borrowers as the core service provided by banks (Diamond & Dybvig 1983; Diamond & Rajan 2001; Song & Thakor 2007). In providing intermediation services they match short-term liabilities with long-term assets. Banks obtain liquid assets from savers in order to provide required funds for borrowers expecting high-yielding cash flows. In this process of serving as an intermediary between savers and borrowers, the banking sector channels capital flows into the economy. Therefore, the healthy and efficient performance of the banking sector is vital for the economy.

With the aim of improving the performance of the banks, policy makers, particularly in developing countries, have introduced reforms in the banking sector. These reforms are aimed at creating more competitive market environments in the banking sector in order to promote higher performance through competition. Hicks (1935) stated that "the best of all monopoly profits is a quiet life" highlighting the importance of market competition for economic expansion. First, it is believed that more competition in the banking sector encourages banks to reduce the prices of their services and minimise cost inefficiencies. Second, a higher degree of competition reduces the monopoly power of banks, avoiding the incidence of monopolistic rent. Accordingly, a competitive-market environment enables more efficient allocation of resources and therefore improves productivity and growth of the overall economy (Hunt 1999; Aghion & Griffith 2008). In line with this, the Sri Lankan government has also introduced an array of banking sector reforms since 1977 which are aimed at establishing a competitive banking market. The decade from 2006 to 2016 has been the most liberalised period for the country's banking sector. Encouraged by the peaceful domestic environment prevailing in Sri Lanka after the end of the armed conflict, policy makers have further extended financial reforms and have introduced prudential measures to realise the higher growth potential which was not achieved due to the armed conflict.

The reforms and regulations during the post-conflict period have focused not only on improving the banking sector performance at the national level, but also on achieving broad-based and inclusive growth through banking sector expansion in regional areas as a top policy priority. Policy makers were under pressure to target regional balanced

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growth in the post-conflict era to address the roots of the armed conflict.[1] Some policies targeted an improvement in the regional dispersion of bank branches, and enhancing access to finance and credit disbursement into the agriculture sector. A favourable economic environment has prevailed during the post-conflict era, with peaceful social and market environments along with an overall expansion in the Sri Lankan economy. This thesis aims to evaluate changes in the efficiency and productivity of the banking sector in the period immediately before and the period after the end of the armed conflict, their determinants and regional disparities with the objective of providing recommendations for further improvement of the performance of the banking sector in Sri Lanka. Going beyond the existing literature on banking sector efficiency and performance, the following research questions are addressed in the thesis.

1) Did the efficiency and productivity of the banking sector in Sri Lanka improve in the post-conflict period?

   As mentioned previously the Sri Lankan economy recorded impressive growth, particularly during the period immediately after the armed conflict. This growth was driven by a number of factors such as improved security conditions in the country, a revival of economic activities in conflict-affected areas, expanded access to productive agricultural land, continuous public sector investment in infrastructure and an improvement in investor sentiment (CBSL 2010; 2011; 2012a). Despite fragile economic conditions in the advanced countries from 2009 onwards after the global financial crisis (GFC), the Sri Lankan economy has

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[1] According to the academic literature, some of the main roots of the armed conflict which ended in 2009 in the Northern and Eastern regions derived from regional disparities (Grobar & Gnanaselvam 1993; Abeyratne 2004).

shown robust economic growth. In line with this, banking sector credit has also expanded rapidly. In evaluating the performance of banks, the impact of this economic expansion can be considered as an exogenous shock to the banking market. The performance of the banks during the post-conflict era will be compared with banking performance in the period immediately before the end of the armed conflict.

2) Has there been a significant difference between the efficiency and productivity of foreign commercial banks, domestic commercial banks and domestic specialised banks in Sri Lanka?

After adopting an open market economy Sri Lanka liberalised its financial sector thereby enabling the formation of private domestic commercial and specialised banks. Although foreign banks had been operating in Sri Lanka since the pre-independence era, restrictions on their expansion were removed with economic liberalisation in 1977. In the aftermath of economic liberalisation and continuous reforms in the banking sector, a competitive market environment for their operation in the country has been achieved. However, two fully state-owned banks are influenced by the government development objectives since they are involved in government-subsidised credit schemes. Further, there can be differences in the performances of the banks with respect to whether they are foreign or locally owned, their use of technology and the scope of their business focus. The banks used in this study were divided into three main groups: domestic commercial banks, foreign commercial banks and domestic specialised banks. Domestic commercial banks were further divided into fully state-owned and private banks

for a comprehensive analysis of banking efficiency across the groups. The efficiency and productivity of these groups are compared for the period 2006–2014.[2]

3) Is banking sector efficiency affected by the growth of branch networks, geographical dispersion and other factors?

Sri Lanka's banking sector recorded a significant expansion in terms of its geographical dispersion and number of branches concurrent with an overall expansion in the economy, pent up demand for banking services in conflict-affected areas, and policies implemented by the CBSL aimed at encouraging the geographical dispersion of bank branches during the period 2006–2014. Although banking sector expansion is generally encouraged by policy makers, there is a growing body of literature that raises the possibility of a decline in efficiency due to "over-branching", informational asymmetries, lack of knowledge of new market conditions and insufficient assessment of socio-economic conditions (Berger et al. 1997; Battese et al. 2000; Berger & De Young 2006; Vu & Turnell 2010).[3] In addition to geographical and branch network expansion, a number of prudential measures with respect to capital adequacy, corporate governance, credit disbursement and ownership structure were implemented by policy makers during the period 2006–2014. Therefore, an evaluation of the impact of these factors on banking sector efficiency in   Sri Lanka is both timely and pertinent. A multidimensional regression analysis is used to evaluate the influence of

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[2] Foreign banks in Sri Lanka were not required to publish their detailed financial accounts before 2007. Therefore, the data available for analysis pertain to the period 2006–2014.

[3] These policy directives are used to expand branch networks in developing countries for improving access to finance in rural areas (Burgess & Pande 2003; Reddy 2006)

geographical and network expansion as well as these other factors on bank efficiency.

4) How does bank efficiency differ across the major regions in Sri Lanka, and what impact do socio-economic factors have on regional level banking efficiency?

It has been widely discussed, and is also commonly accepted, that Sri Lanka's armed conflict was fuelled directly by social unrest as an outcome of regional economic disparities (Grobar & Gnanaselvam 1993; Arunatilake et al. 2001; Abeyratne 2004; Sriskandarajah 2005; Wijerathna et al. 2014). Therefore, with the aim of achieving inclusive and broad-based economic growth and reducing the likelihood of future internal conflict, addressing regional disparities in terms of access to finance through a wider geographical dispersion of banking services was given a high priority in the policy agenda at the end of the armed conflict in 2009. Low banking density was found in regions other than the Western region, including the Northern and Eastern region during the period before the end of the armed conflict. Accordingly, directives were issued by the CBSL aimed at expanding the outreach of banking services. However, there is a possibility of a decline in the efficiency of the banks at the regional level due to "over-branching" and expansion may simply result in disparities in banking efficiency at the regional level becoming more entrenched.

In addition, differences in socio-economic conditions could also influence regional level disparities in banking efficiency and these differences would also need to be addressed (Lozano-Vivas et al. 2002; Bos & Kool 2006; Glass &

McKillop 2006; Kenjegalieva et al. 2009; Battaglia et al. 2010; Liu et al. 2013a). Therefore, this study assesses differences in banking sector efficiency across the nine regions in Sri Lanka using regional level banking data. The impact of socio-economic factors on regional level banking sector efficiency will also be incorporated and evaluated. The findings from this evaluation will be useful particularly for the regional level policy formulations for achieving balanced regional growth for Sri Lanka to prevent a recurrence of armed conflicts in the future.

1.3 Methodology and data

The most appropriate methodologies in the context of developing countries have been employed in this study to address the research questions. There are two commonly used approaches in measuring banking sector efficiency: non-structural and structural (Hughes & Mester 2010). A variety of financial ratios can be incorporated in a non-structural approach to assess banking sector efficiency. Although a non-structural approach may be motivated by informal and formal theories, there is no unifying framework for these studies based on general economic theory. On the other hand, a structural approach for measuring banking efficiency is based on a theoretical model of the banking firm along with the concept of optimisation. Structural approaches account for the multidimensional characteristics and nature of banking sector performance (Berger & Humphrey 1997). Parametric stochastic frontier analysis (SFA) and non-parametric Data Envelopment Analysis (DEA) are the two most commonly adopted structural methods used for assessing banking sector efficiency. Both methods derive the efficiency of a firm (or a bank in this instance) against an estimated efficiency frontier.

SFA derives efficiency based on regression models by separating an inefficiency term from the error term. Then, the purely random error component is assumed to be due to the impact of factors beyond the control of the production process (Aigner et al. 1977; Kalirajan & Shand 1994; Coelli et al. 2005). In contrast, DEA estimates efficiency against an estimated efficient frontier formed based on a linear programming technique. The random errors in the DEA framework are assumed to average out to zero over time (Seiford & Thrall 1990; Henderson & Zelenyuk 2007). Since SFA and DEA have their own weaknesses and strengths a researcher's choice of one method over the other for measuring efficiency is mainly dependent on aspects such as the characteristics of the dataset and industry, the research question(s) and the sample size.[4]

This study employs DEA for three main reasons. First, DEA does not require a specific functional form to be followed by the data (Wilson 2008). This avoids the risk of contaminating efficiency measures due to misspecification of the functional form of bank production (Havrylchyk 2006). In general, production processes in the services sector, particularly banking services, are more complex than they are in the production sector and it is quite challenging to accurately specify the functional form. Second, DEA works better with small samples than SFA. Unlike SFA, which needs a relatively large sample to estimate a substantial number of parameters, more consistent coefficients can be derived from DEA using a small sample (Seiford & Thrall 1990; Sathye 2001; Coelli et al. 2005). Third, DEA can incorporate multiple outputs, an advantage over SFA which

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[4] According to Fried *et al*. (2008) a similar conclusion can be expected from both DEA and SFA for good quality data, and choosing one method for an efficiency analysis does not discount usage of the other method. See Matoušek and Taci (2004) for a review of the DEA and SFA approaches.

allows only one output.[5]

Since DEA assumes the non-existence of random errors, it may provide downward biased estimates for a finite sample of banks. Although the bias could be avoided asymptotically with large samples, efficiency studies in banking mostly do not deal with large samples.[6] Therefore, a bootstrap simulation procedure has been employed in recent studies to correct for such bias (Simar 1992; Simar & Wilson 1998; 2000). Accordingly, several bootstrap-based DEA models have also been used in this study to conduct an efficiency analysis. An aggregate efficiency measure based on the sub-sampling bootstrap model that was introduced by Färe and Zelenyuk (2003) and Simar and Zelenyuk (2007) is used to evaluate and compare the efficiency of different bank groups and regions of Sri Lanka. Unlike conventional firm-specific efficiency scores, an overall measure of the performance of a group of banks is provided by aggregate efficiency measures which consider the relative importance of each bank with respect to their size.

Further to the aggregate efficiency measures, the Li test, adapted by Simar and Zelenyuk (2006) in the context of efficiency and meta-technology techniques introduced by O'Donnell et al. (2008), are also utilised in this study to compare the performances of different bank groups. To avoid serial correlation which occurs in conventional OLS and Tobit regression models, a semi-parametric bootstrap truncated regression model is used in this study to evaluate the influence of environmental factors on banking sector efficiency at both the national and regional levels.

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[5] A detailed discussion of the DEA models is provided in the Chapter 4.

[6] The consistency of DEA estimates improves with increased sample size for given input and output dimensions (Banker 1993).

In terms of productivity analysis, the Global Malmquist productivity index (GMPI), introduced by Pastor and Lovell (2005), is also employed to explore differences in banking industry productivity in the 2006–2014 period. The GMPI is used in this study to measure productivity with respect to a common frontier for the 2006–2014 period, thereby enabling a comprehensive comparison of productivity before and after the end of the armed conflict. Further, the GMPI avoids the possibility of an infeasible solution with respect to variable returns to scale (VRS) which is the most appropriate scale for banking efficiency analyses. The GMPI also enables the decomposition of productivity change into technological change and technical efficiency change.

Data

Two sets of data have been employed in this study. The first set of banking data has been extracted for the period 2006–2014 from the financial statements of all commercial and specialised banks operating in Sri Lanka. The national level banking efficiency analysis is based on this data set. It was not compulsory for foreign banks to publish detailed income statements prior to 2006, and, therefore, financial data required for the analysis is only available for the period 2006–2014. Further, the reference period is selected to cover the period extending from before the end of the conflict period until after the end of the conflict. As per the directive issued by the CBSL since late 2005, data has been published by the banks which adhere to Sri Lanka Accounting Standards as far as possible. The data set is unbalanced with a few missing observations, mergers and new entrants into the banking market. The aggregate efficiency does not need a balanced data set and GMPI is calculated based on the balanced part of the data set. The second data set was prepared

by using the regional level aggregates of financial data of the banks. The regional level banking efficiency analysis is based on this data set. Regional level data is available for the period 2011–2014 covering the post-conflict period only, which recorded a significant geographical dispersion in the banking sector.

1.4   Contribution of the study

This thesis makes a contribution to the literature on banking efficiency in several unique ways. First, it assesses bank efficiency dynamics when the banking sector expands in terms of credit, number of branches and geographical dispersion during a post-conflict period with specific reference to the emerging market of Sri Lanka. The study is not only the first to examine changes in banking efficiency in the post-conflict era of   Sri Lanka but is also an original contribution to understanding the dynamics of efficiency in the banking sector during a post-conflict economic boom occurring in conjunction with branch expansion. Second, the Simar and Zelenyuk aggregate efficiency measures are applied for the first time in this study to compare the banking industry across the two periods, providing a comprehensive assessment of post-conflict banking performance in Sri Lanka. A new framework for future banking studies to use for assessing industry-level efficiency across two time periods is provided by this methodology. The methodology accounts for the size of the banks in comparing their performance over time. Third, this study is among a limited number of studies which explore the expansion-efficiency nexus in the banking sector, particularly in the context of a developing country. Fourth, this study introduces a new approach to comparing regional level banking performance by employing an aggregate efficiency technique. A comparison of banking performance based on aggregate efficiency assumes homogeneity within regions while enabling

heterogeneity across regions, and is an ideal framework for tracking disparities in regional level banking efficiency. Therefore, this is a pioneer study which addresses regional disparities in banking efficiency to formulate policies for achieving balanced regional growth.

1.5   Organisation of the thesis

This thesis has eight chapters. After this introductory chapter the rest of the thesis is structured as follows: Chapter 2 presents an overview of the evolution of the Sri Lankan financial sector from 1948 to the present, covering the post-independence era. The chapter starts by providing an overview of economic and social developments in the post-independence era. Key developments in the financial sector are also analysed over time. In addition, this chapter provides a detailed description of the current state of the banking industry in Sri Lanka. The chapter concludes by highlighting a number of contemporary issues facing the country's banking sector.

Chapter 3 reviews related literature on banking efficiency by using the most relevant and frequently cited studies. The review also includes an examination of the methods used in efficiency analyses. In particular, this review summarises the impact of bank-specific factors, as well as business, macroeconomic and socio-demographic environment and other related factors, on bank efficiency. Literature on the finance-growth nexus is also reviewed to highlight the importance of the impact of financial sector performance on economic development.

Chapter 4 explores the methods used in analysing the efficiency and productivity of the

banks in Sri Lanka. A detailed description of the calculation of efficiency scores and the bootstrap technique used for bias correction is provided. The theory behind the compilation of aggregate efficiency, bootstrap techniques and meta-frontier techniques is discussed. Further, the chapter provides a description of the semi-parametric bootstrap truncated regression used in the analysis. The chapter concludes with a presentation of the Global Malmquist productivity index, the conventional Malmquist productivity index, and their disaggregation.

Chapter 5 provides an analysis of banking sector efficiency based on a group comparison and a double bootstrap truncated regression model. In addition, analysis of productivity changes over the period 2006–2014 is also presented. Therefore the chapter consists of three analyses: First, efficiency levels between the different bank groups are compared. In particular, banking efficiency before the end of the conflict is compared to that in the post-conflict era. Further, changes in banking sector efficiency are also analysed across different bank ownership groups, namely foreign commercial banks, domestic commercial banks and domestic specialised banks, providing a comprehensive analysis of the banking sector. Second, the impacts of the environmental factors including geographical dispersion and expansion in branch networks on banking efficiency are assessed using double bootstrap truncated regression models. Third, productivity changes in banks are also analysed over the period 2006–2014 and across the three different banks groups as mentioned earlier.

Chapter 6 presents an analysis of the regional level banking sector performance of   Sri Lanka. The chapter comprises two sections. First, a comparison of banking performance

across Sri Lanka's nine regions is provided. Second, a double bootstrap truncated regression model is employed to evaluate the impact of regional level socio-economic changes on banking sector performance.

The aim of Chapter 7 is to suggest key policy implications and recommendations in order to further develop the banking sector of Sri Lanka based on the empirical findings from Chapter 5 and Chapter 6. Strategies to address contemporary issues in the banking sector are also discussed, along with suggested policy implications and recommendations.

The eighth and final chapter summarises the major findings of the thesis and highlights its key contributions. It also provides answers to the research questions posed in this chapter. The chapter concludes by outlining some limitations of this study and suggesting areas for further research in banking sector performance, both in Sri Lanka and more generally.

1.6   Summary

This chapter has provided a description of the analysis of banking sector efficiency of Sri Lanka. The research questions were presented along with the methodological framework and the data employed to address the research questions. The contributions of the study have also been briefly discussed and the chapter concludes with an outline of the remaining chapters. Since this study has been conducted in the context of the   Sri Lankan banking sector, a holistic analysis of past developments and current status of the financial sector in line with macroeconomic developments is important for an in-depth understanding of the research questions. Therefore, the next chapter provides an analysis of the stages of economic development, the evolution of the financial sector at both the

national and regional levels, and an examination of the current state of the financial sector

in Sri Lanka.

Chapter 2 Banking sector framework and developments in Sri Lanka

2.1 Introduction

This chapter explores the economic development of Sri Lanka from the pre-independence era to the present, and in doing so highlights developments in the country's banking sector. As is the case in many emerging economies the banking sector is the dominant player in the financial sector in Sri Lanka, controlling most of the financial flows and possessing most of the financial assets. Economic reforms introduced after achieving independence from the United Kingdom in 1948 brought structural change in the financial sector with the establishment of the CBSL. State-owned commercial banks were established after independence to provide banking services to all segments of Sri Lankan society. There was a gradual increase in banking penetration facilitated by government intervention in terms of establishing government banks and expanding their branch networks and outreach. Private sector and foreign financial institutions were further encouraged by economic reforms introduced in 1977 aimed at encouraging investment in the banking industry (CBSL 1998). Although the penetration of banking services improved with these reforms (Hemachandra 2003), the concentration of most foreign and private commercial banks in the Western region and major cities paved the way for regional disparities in banking services, which contributed to regional income and economic development disparities.

Improving the efficiency and productivity of the banking sector at both the national and regional levels represents a critical challenge for Sri Lanka as a lower middle-income country which is confronting the problem of stimulating all sectors of the economy with

the objective of escaping its "middle income trap".[7] Since the banking sector dominates the financial sector which serves as the backbone of the economy, all sectors would benefit from greater efficiency and productivity in the banking sector (Shaw 1973; Levine 2005).

The remainder of this chapter proceeds as follows. Section 2.2 provides an overview of the Sri Lankan economy after independence in 1948. The evolution of reforms and structure of the banking sector in Sri Lanka is discussed in Section 2.3. This section explores the role played by policy makers in the development of the financial sector, structural reforms introduced in the post-independence era and regional branch network expansion of the banking sector. An overview of the overall financial sector of Sri Lanka is presented in Section 2.4 followed by some contemporary issues of concern to the banking sector in Sri Lanka in Section 2.5. Section 2.6 provides a summary of the chapter.

2.2   An overview of the Sri Lankan economy

Sri Lanka (formerly Ceylon) is an independent island country of 65,610 square kilometres located in the Indian Ocean off the southeast coast of the Indian subcontinent. The estimated mid-year population in 2015 was 21 million, an increase of 0.9% compared to the previous year (CBSL 2015a). The population density is 334 persons per sq. km and about 80% of people live in rural areas, including the plantation estates. Sri Lanka consists

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[7] There are some issues that prevent some countries from advancing from a middle income level to a higher income level. These countries have been stuck in what is called a 'middle income trap', with a deficiency or loss of conducive factors which play a major role in uplifting the economy into a higher income state. The loss of comparative advantages such as cheap labour inputs with increased wages, unchanged export structure, competition due to the existence of low wage rates in newly emerging countries, low value-adding in some sectors due to poor productivity, lack of innovation, result in slow economic growth and stagnant per capita income in these middle income economies.

of several ethnic groups. The majority Sinhalese account for 74.9% of the total population while Sri Lankan Tamils and Muslims or 'Moors' comprise 11.2% and 9.2% of the population respectively. Indian Tamils comprise 4.2% of the Sri Lankan population.[8] In addition to these main ethnic groups, 0.5% of the population consists of small communities including aboriginal Veddahs, who are considered to be Sri Lanka's original inhabitants. There are four major religions practised in Sri Lanka, namely Buddhism (69%), Hinduism (15%), Christianity (8%) and Islam (7%).

Sri Lanka has maintained participatory democracy since achieving independence in 1948, and has one of the longest democratic traditions in the Asian region. All the democratically elected governments in the post-independence era focused on nation building through introducing policies for socio-economic development. The next sections give a brief description of the evolution and the structure of the Sri Lankan economy, while highlighting socio-economic developments in the post-independence era.

2.2.1 Structure and evolution of the Sri Lankan economy

According to historical records, the cultivation of paddy and other food crops was the main livelihood of Sri Lankan inhabitants from the beginning of settlements by migrants from India in the sixth century BC until the British invasion. The colonial rulers, the United Kingdom, introduced plantation crops, mainly tea, rubber and coconut into the agriculture sector as export crops. With the gaining of independence from the United Kingdom in 1948 the economy of Sri Lanka was mainly driven by the agriculture sector, including plantation crops. At this time, more than half of the total population of seven

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[8] Indian Tamils are descendants of people who were brought to Sri Lanka in the 19th century as tea and rubber plantation workers by the colonial rulers.

million was engaged in agriculture for its livelihood (CBSL 1998). Production and trade in three plantation crops, namely tea, rubber and coconut contributed more than 50% of the national income (Karunathilaka 1971). During this period the plantation sector generated 90% of the country's foreign exchange earnings (Kelegama 2006). The performance of other key sectors of the economy such as trade, banking, commerce, transport and insurance also depended on the plantation sector. The export and import sector combined contributed 70% of the gross domestic product (GDP) and the economy was opened to free trade in 1948 (Karunathilaka 1971).

The post-independence period 1948–1960

From the British, Sri Lanka inherited a well organised export sector along with commercial links to Europe when it achieved independence in 1948. The first budget speech for an independent Sri Lanka in 1948 outlined the policies and development plans for implementation. The budget was mainly focused on accelerating the growth of the economy by increasing the productive capacity of the agricultural and industrial sectors. More attention was paid to agriculture, particularly paddy cultivation. Paddy was identified as the main crop for import substitution; however, the government also invested in new industries such as cement, paper, coconut oil and handloom as estate-owned enterprises catering to the domestic market. In addition, state investment targeted cottage industries including the handloom industry, weaving, pottery and woodwork. The government also focused on developing the domestic agricultural sector with new settlements in the dry zone which turned out to be successful. Earnings from the plantation sector were mainly used to buy food imports.

In 1956 a new government came to power with a framework of socialist policies. It continued with many of the programmes introduced by the previous government and it endorsed and continued the market-based policies of the pre-independence period. Import substitution in agricultural products remained one of the major policies of development, and government investment programmes allocated substantial funds for developing settlements in new agricultural lands in the dry zone. The government expanded import substitution policies into the industry sector. The State Industrial Corporation Act no. 48, which empowered the government to set up and carry out any industrial undertaking, was passed in 1957. The establishment of state enterprises was the main vehicle for development and domestic industries were encouraged by the government, relying on the "infant industry" argument (CBSL 1998). The industrial sector was mostly controlled by the government while agriculture remained primarily privately owned during this period. Economic expansion lagged far behind the expectations of the policy packages introduced and Sri Lanka recorded an average annual economic growth rate of only 3.4% from 1951 to 1960. The ineffectiveness of the policies pursued by policymakers was reflected in the minimal changes in the structure of the economy between 1950 and 1960 (Table 2.1).

Period of import substitution and industrialisation 1961–1977

During the period from 1961 to 1977 the intensity of government intervention in the economy was very high, and import substitution remained the main theme of the government's policy agenda. More protective barriers were visible than just high tariffs. The government announced a wide range of incentives to encourage industrialists in 1961. The main components were an exemption of profit from tax, tax rebates on purchases of plant and machinery, depreciation allowances, concessionary rates of duties

on plant and machinery, and the protection of domestic industries by import controls such as tariffs and regulations. The government established two state-owned commercial banks in the early 1960s to help small and medium enterprises (SMEs) that found it difficult to get financial assistance from foreign and private commercial banks. Industrial protection and incentives were provided by the government to help import-substituting industries in both the public and private sectors. The socialist policies introduced by the government which came to power in 1956 continued until 1965, as it got the people's mandate in 1960 to continue its pro-socialist policies.

Table 2.1 : Structural changes of the economy based on GDP (constant prices) share, 1950–2014

Year	1950	1960	1977	1990	2014
Agriculture	35.0	33.0	30.7	23.2	10.1
Industry	24.0	23.0	28.7	28.5	32.3
Services	41.0	44.0	40.6	48.3	57.6

Source: CBSL (2015b)

In 1965 a new government with more market-oriented and liberalisation policies came into power. A significant new development in the 1965–1970 period was the success with which the government was able to strengthen the trade relationships with western countries particularly the United Kingdom and the United States of America (US) (Gunatillake 2000). Although there were some economic liberalisation attempts during this period, the government did not introduce any major economic reforms (Cooray 2000). The government placed greater emphasis on export-promoting industries by deviating from the import-substitution industrialisation policy framework of the previous government. During this period, to encourage foreign investment for industrial development, the government offered some incentives and these were included in a white paper issued in 1967. These incentives included: a relaxation of the moratorium on the

remittance of dividends, interest and profits; tax concessions including a five-year tax holiday; and high depreciation allowances for tax purposes. The government also safeguarded foreign investments from the threat of nationalisation without adequate compensation. However, liberalisation attempts were badly affected by balance of payments problems and a deterioration of the exchange rate.

The left-centre political party that had led the country for the period 1956–1965 came into power again in 1970 and adopted a stringent import substitution strategy, with greater direct government involvement. Further, an export promotion policy was aimed at reducing the country's heavy dependence on traditional exports such as tea, rubber and coconuts. The export promotion strategy failed, however, due to contradictory economic policies adopted by the government. The government adopted closed door economic policies aimed at the development of manufacturing industries behind protective barriers (CBSL 1998). During the period 1970–1977, government intervention and state capital participation in industry increased due to direct investment by the government and the nationalisation of private enterprises under the Business Undertaking (Acquisition) Act of 1970. Meanwhile, agricultural policies were targeted at achieving self-sufficiency in food and non-food production, with price control of essential items and discouraging imports of consumer goods including food. However, these policies led to a scarcity of essential items due to a lack of domestic production and demand pressure.

During the period from 1961 to 1977 the economy expanded at an annual average rate of 3.8% in real terms. The period 1966–1970, with some efforts at export-promotion and liberalisation, recorded an average annual growth rate of 5.5% (Figure 2.1). The average annual real growth rate of GDP fell to 2.9% during the period 1971–1977 when the

government placed more emphasis on import substitution by intensifying state intervention in the economy. The adverse economic impact of the oil price hike in 1973 also contributed to lower growth during this period. As illustrated in Table 2.1 there was only a slight change in the structure of the economy during the period 1961–1977.

Figure 2.1 Real economic growth (GDP) in Sri Lanka for the post-independence period
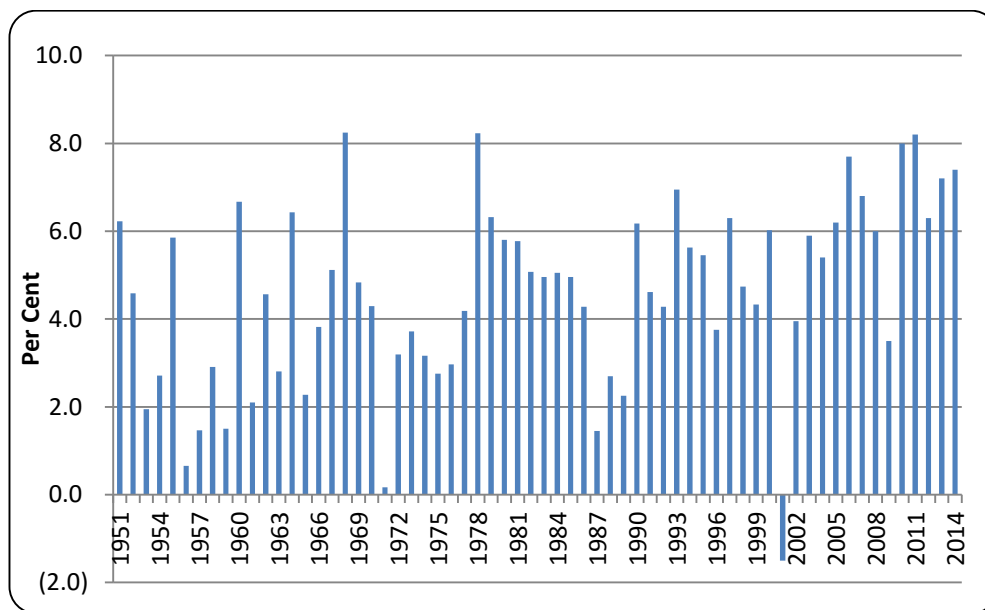
Source: Author's calculations based on CBSL Annual Reports (various years)

Trade liberalisation and export orientation since 1977

With the aim of emulating the East Asian Tiger economies, and in response to the dismal economic outcome of the inward-looking import substitution policies in the past, the new government which came into power in 1977 adopted open market economic policies.[9] It did this by introducing far-reaching reforms to make a shift from import substitution policies to export oriented policies. This involved removing an array of government controls in different sectors of the economy. The economy moved to a higher growth path

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[9] A group of four countries namely Hong Kong, Singapore, South Korea and Taiwan were known as the Asian Tiger economies. All four countries were able to maintain high levels of economic growth driven by the momentum of export expansion and industrialisation which they began in the late 1960s.

with these open market policies, with an improvement in exports, investment and productivity. All the reforms focused on encouraging the active participation of the private sector. State sector monopolies were scaled down to pave the way for private sector involvement. In order to encourage foreign investors, with or without local collaboration, the government established "export processing zones" and provided attractive tax incentives and infrastructure facilities to investors in these zones. As a part of trade liberalisation, the government set about removing quantitative restrictions and scaling down nominal tariffs, which had become as high as 500% on some imports (Karunaratne 2000). With further economic reforms in 1978, the economy grew by 8.2% in real terms as against the 4.2% growth recorded in 1977.

Despite intensification by the LTTE in the armed struggle against the Sri Lankan government in the Northern and Eastern regions in 1983, the growth momentum started by the reforms continued until 1986.[10] With economic expansion, the government, which had dedicated its efforts to further developing the market economy, was able to extend its term for another six years by winning the presidential elections in 1982 and a referendum to extend the term of the parliament in 1983. Although the Sri Lankan economy shifted to a higher growth path with the introduction of the open market system, deceleration of economic growth was observed from the early 1980s. From 1978 to 1986 the country recorded an average annual real growth rate of 5.6%. Foreign investment fell, with a

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[10] The LTTE (Liberation Tigers for Tamil Eelam) organisation which was formed in 1976 fought for the establishment of a separate state in the Northern and Eastern regions, claiming that the Tamil speaking people in the region were being marginalised by the Sri Lankan government and pointing to the socio-economic obstacles faced by the people living in these regions. LTTE intensified the armed struggle against the government after 1983. Government forces crushed the LTTE rebels in mid-May 2009, capturing all the lands controlled by their de facto state for more than a decade.

decline in investor sentiment and some sectors such as tourism were badly affected by the deterioration in security conditions.

Economic expansion was further curtailed by unfavourable developments in the southern parts of the country. A Marxist group raised arms against the government in 1987 and their demand was for a change in the political system to provide equal opportunities for all people.[11] Although there was a cessation of hostilities from mid-1987 to early 1990 between the Sri Lankan government and the LTTE with the mediation of the Indian government, the security situation deteriorated in the other seven regions due to a Marxist-led insurrection. Economic growth further decelerated, with a decline in domestic demand. In late 1989 the government managed to crush the Marxist rebels in the southern part of the country and the armed struggle was again limited to the Northern and Eastern regions. During the period 1987–1989, annual economic growth in terms of percentage increases in real GDP fell below 3%.

In the early part of the 1990s the government took some steps to further liberalise the economy and improve the efficiency of state-owned entities through privatisation. However, the hostilities between the LTTE and government forces resumed in 1990 with the collapse of the ceasefire. Although somewhat moderate growth was observed in the 1990s with structural reforms introduced by the government through privatising government monopolies in key sectors of the economy, an uncertain political and

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[11] The Marxist armed insurrection started in 1987 and the government was able to crush the rebels by deploying more forces in the other seven regions since Sri Lankan armed forces had withdrawn from the Northern and Eastern regions under an agreement between India and Sri Lanka. Indian peace keeping forces were deployed in those two regions in place of Sri Lankan armed forces. In 1994 the Marxist rebels entered the democratic process as a political party. It was estimated that 60,000 people died during the period of the Marxist-armed insurrection from 1987 to 1989.

economic environment due to the ethnic conflict limited the exploitation of the country's growth potential. A new government came to power in 1994 as a coalition of left leaning parties pledged to continue open market policies. The country recorded an annual average real GDP growth rate of 5.3 % from 1990 to 2000.

After the 9/11 attack on its main export destination the US, Sri Lanka experienced an economic downturn with real GDP declining by 1.5% in 2001. In addition to this external shock, economic growth was further dampened by bad weather conditions in 2001 and deterioration in security conditions with an attack on the country's only international airport by the LTTE rebels. The economy recovered from the 1.5% decline in 2001 with the ceasefire between government troops and the LTTE during the 2002–2004 period. In general, despite the civil conflict in the Northern and Eastern regions of the country, the Sri Lankan economy recorded real average annual growth of around 6% during the seven years from 2002 to 2008. This economic growth was underpinned by the services sector along with a high public and domestic private investment drive. However, public investment in the country was curtailed by high defence expenditure due to the intensified military operations in the Northern and Eastern regions.

Due to the Global Financial Crisis of 2007–2008 economic growth fell to 3.5% in 2009, while the country achieved peace through successful military operations. With a peaceful domestic environment after the ending of armed conflict, Sri Lanka recorded a GDP growth rate of over 8% in both 2010 and 2011. This growth was driven by an expansion of agricultural production arising from having accessibility to agricultural land in conflict-affected areas, an improvement in domestic demand with reconstruction activities, a revival of economic activities in conflict-affected areas and domestic and

foreign investments in infrastructure. This was an unprecedented feat as Sri Lanka had never before recorded two consecutive years of eight per cent or higher growth of GDP in its post-independence history. Despite the fragile economic conditions prevailing in advanced countries at this time, Sri Lanka recorded impressive GDP growth rates of 6.3%, 7.2% and 7.4% in 2012, 2013 and 2014 respectively, due to further expansion of agricultural production and the revival of livelihoods in the conflict-affected Northern and Eastern regions, and foreign and domestic investments in infrastructure, manufacturing and the services sector (CBSL 2012a; 2014).

The economy had attained a higher growth path after the ending of the armed conflict. Continuation of this growth momentum had become dependent on the country's exploitation of its growth potential in a peaceful post-conflict environment. Having realised the importance of liberal economic policies, all political parties coming into power during the previous 39 years had continued their commitment to strengthening the open market-friendly economic policy framework that had existed since 1977. Private sector participation in key sectors of the economy such as education, finance, infrastructure and health had been further encouraged by structural reforms aimed at strengthening the open market policies. Changes in real economic growth and nominal per capita income in US dollars are presented in Figures 2.1 and 2.2 respectively. Previous governments had implemented various development programmes aimed at enhancing regional economies and ensuring economic expansion in all regions in line with overall economic growth. The next section will analyse and discuss economic expansion at the regional level.

Figure 2.2: Per capita GDP (US$ nominal) of Sri Lanka (1959–2014)
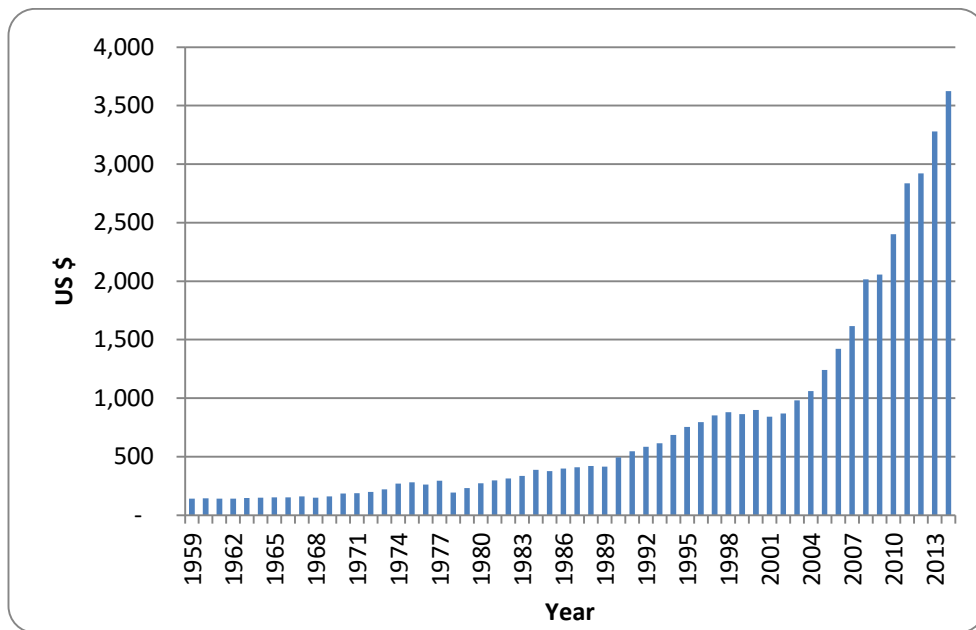
Source: Author's calculations based on CBSL Annual Reports (various years)

Developments at the regional level

The regions in Sri Lanka were demarcated by the British rulers who governed the country from 1815 to 1948. The main purpose of the regional demarcation was to decentralise the administrative system and achieve better control in handling economic and political affairs within the country. The infrastructure, particularly the road network and railway lines, developed by the British rulers in the pre-independence era reduced the geographical division of the country. However, limited attention was paid to social welfare and the economic development of rural regions away from the capital Colombo by the British rulers, who focused their administrative system on getting the maximum benefits from the main plantation crops, namely tea, rubber and coconuts. Upon achieving independence, all Sri Lankan governments implemented some development programmes to improve the socio-economic conditions of the people who were living in rural areas. Expansion of agricultural lands in the dry zone and irrigation projects, coupled with hydropower projects, were among them. However regional level comprehensive

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development plans consistent with national plans were not implemented to address regionally specific problems and enhance regional economies.

After the establishment of a provincial council system in 1987 through the thirteenth amendment to the constitution of Sri Lanka, there were wider appeals for regional economic development and eliminating regional economic disparities, mainly from politicians and policymakers. Regional development banks were established in 1988 covering all districts, except Colombo, to improve the availability of credit for small and medium industries in regional areas. Some services provided by the central government came under the auspices of provincial councils after the thirteenth amendment of the constitution. In addition, provincial councils were vested with the power to collect and use some of the taxes from residents and entities within their regions.[12] After the establishment of the provincial council system in 1988, a number of regional level development programmes were implemented by the provincial councils, and the central government also provided funds for the provincial councils through the national budget.

Provincial councils for the Northern and Eastern regions were not active until the election of new members in 2013, after the ending of the armed conflict in 2009. Therefore, large-scale development programmes for the Northern and Eastern regions were not implemented through the provincial council until 2013. Other than the Northern and Eastern regions, some other regions are also lagging behind due to a number of factors

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[12] Provincial councils are vested with powers to collect taxes such as stamp duty on transfer of properties, taxes on business turnover, charges on Fauna and Flora Ordinance, taxes on lotteries operated only within the region.

including poor infrastructure, low productivity levels and climatic conditions. Therefore, significant disparities across the regions still remain. Differences in per capita income across the regions are shown in Figure 2.3.

Figure 2.3: Per capita income by region (US dollars nominal)
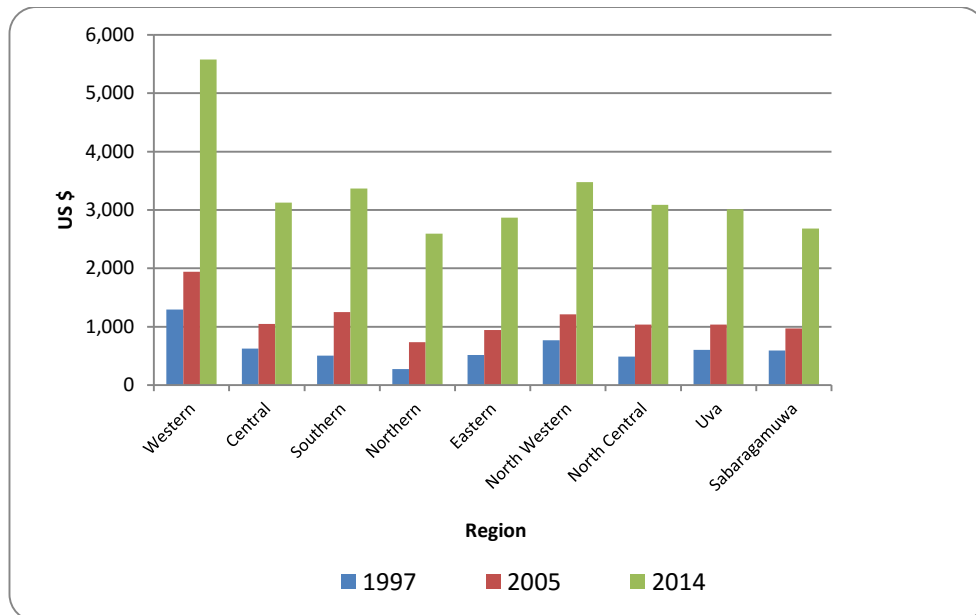
Source: Author's calculations based on CBSL (2008; 2015b)

The Western region has consistently recorded the highest per capita income, and all other regions are far below the Western region. Although there was an increase in the per capita income of all the regions during the period 1997–2014, disparities remain. The conflict-affected Northern region has the lowest per capita income. The Western region contributes 42% of national GDP and there was no significant change in this contribution between 1997 and 2014 (see the Table A.1 in Appendix A). In line with these macroeconomic developments in the post-independence history of Sri Lanka, socio-demographic conditions have also improved. The next section provides a brief review of the improvements in socio-economic conditions.

2.2.2 Developments in socio-economic conditions

Since independence, socio-economic conditions in Sri Lanka have shown a gradual improvement and this has been underpinned by macroeconomic developments, government welfare such as free education and health services and special programmes aimed at alleviating poverty and inequality. During the pre-liberalisation period from 1948 to 1977, state intervention was mainly focused on rural development and income redistribution strategies such as providing government subsidies. Some of the state actions for improving rural income and alleviating poverty during this period included new settlements and land allocation for farmers cultivating paddy and highland crops, price guarantees for agricultural products, fertiliser subsidies and a limit on the share of the crop that the tenant farmer should be required to give a landlord. New taxes on wealth, a ceiling on the amount of agricultural land which can be owned by an individual, and a capital levy on taxpayers' wealth held in land, housing, plantation and industry were among the steps taken to minimise income inequality. According to Tables 2.2 and 2.3 the real income of households improved while income inequality declined during the pre-liberalisation period. The government was therefore able to achieve its targets for poverty alleviation and income inequality to some extent during this period. Improvement can be seen among other socio-economic indicators such as the Gini coefficient, schooling, literacy rates and labour force participation. However, a satisfactory performance was not achieved in the unemployment rate.

Table 2.2: Income distribution and inequality

Income Group	Share of total household income (%)								
	1953	1963	1973	1978/79	1981/82	1986/87	1996/97	2003/04	2009/10
Poorest 40%	14.5	14.7	19.3	16.1	15.3	14.1	15.3	11.9	13.3
Richest 20%	53.8	52.3	43.9	49.9	52	52.3	49.9	55.1	54.1
Gini Ratio	0.46	0.45	0.35	0.43	0.45	0.46	0.43	0.46	0.43

Table 2.3: Social indicators in the post-independence period

Indicators	Year of the Sample Survey								
	1953	1963	1973	78/79	81/82	86/87	96/97	03/04	12/13
Literacy Rate (Aged 5 Years and Above), %									
Literacy rate(a)	82.2	80.8	86.2	88.6	86.2	91.8	91.8	92.5	92.7
Male	n.a.	87.1	86.9	89.9	90.9	92.2	94.3	94.5	94.5
Female	n.a.	71.4	74.7	81.1	81.9	85.2	89.4	90.6	91.4
Educational Attainment, %									
No Schooling	41.8	26.8	22.9	15.1	14.9	11.8	8.6	7.9	4.0
Primary	46.8	45.5	43.2	42.9	43.8	41.1	35.2	29.9	n/a
Secondary	9.8	22.7	27.3	29.2	29.8	32.1	35.5	41.0	n/a
Labour Force, Employment and Unemployment									
Labour Force, % of population	40.0	31.7	33.9	34.3	38.0	38.1	39.7	38.9	n/a
Male	56.0	n.a.	48.0	49.7	50.1	51.7	53.0	54.3	n/a
Female	22.9	n.a.	19.8	19.4	26.0	25.4	27.3	24.9	n/a
Unemployment, % of Labour Force									
Male	15.3	n.a.	18.9	7.8	9.2	11.3	6.4	6.3	2.8
Female	20.0	n.a.	36.4	21.3	24.9	23.6	17.5	14.2	5.8
Total	16.6	13.8	24.0	11.7	14.7	15.5	10.4	8.9	3.9
Income Distribution-Income receivers									
Gini Coefficient	0.50	0.49	0.41	0.50	0.52	0.52	0.48	0.50	0.50
Income per income receiver(US$)(b)	23	28	36	39	55	63	101	107	199

(a) A 'literate' person is defined by the DCS Sri Lanka as 'a person who can both read and write with understanding of a short statement'.
(b) Real income per income receiver is based on 1996 prices.

The economy expanded after liberalisation in 1977 due to the generation of new economic activities such as the establishment of free trade zones for export-oriented industries and large-scale public investment in infrastructure projects such as electricity generation and distribution. Economic liberalisation policies were aimed at improving living standards through sustainable high economic growth within a competitive market structure. This expansion resulted in a higher rate of labour absorption, with a concurrent increase in wage levels (CBSL 1998). Policy makers did not consider income redistribution as a goal of economic reforms during this new reform era. However, social welfare programmes

such as rice rations and kerosene stamps continued until 1989 (Gunathialaka 2000). In 1989 the government introduced a new social welfare programme called "Janasaviya". This was a new initiative to alleviate hard core poverty in particular, and it provided income transfers to households for higher consumption to stimulate the economy.

After a change of government in 1994, the Janasaviya programme was replaced by a new welfare programme, "Samurdhi", which had almost the same characteristics except it included an improvement in the monitoring mechanism by recruiting one monitoring officer from each village. Still, 30% of households received social benefits from this programme, accounting for 7% of total government expenditure. With all these welfare programmes and economic expansion, the real income of welfare recipients increased gradually under the liberalised economic policies. Social indicators such as the literacy rate and the educational attainment of the people also improved and showed an upward trend. Therefore, in the area of human development, Sri Lanka's position is far superior to that of other South Asian countries and is comparable with newly industrialised countries in the East Asian region due to this high public investment in social welfare activities and the good education system developed by the colonial ruler the United Kingdom (CBSL 1998).

This is reflected in the Human Development Index (HDI) compiled by the World Bank (see Table A.2 in Appendix A).[13] Sri Lanka achieved a value of 0.7 (the maximum being

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[13] The HDI is a summary index based on adult literacy, life expectancy at birth and per capita GDP adjusted for purchasing power in terms of US dollars. In 1960, Sri Lanka's HDI was higher than that of all other Asian countries except Singapore and Japan. With the high growth momentum in the East Asian region, Malaysia, South Korea and Thailand exceeded the Sri Lankan HDI in the early 1980s.

1) for the HDI. Sri Lanka is grouped in the category of "achievers" with relatively high HDIs. Income inequality, as measured by the Gini coefficient, remained unchanged at the national level during the liberalised economy era, reflecting Sri Lanka's potential for further socio-economic improvement. Since 2010 the unemployment rate has declined to a record low level of below 5% due to the absorption of the labour force arising from the post-conflict economic expansion.

Disparities across the regions are also reflected in the socio-economic indicators. Table 2.4 presents some of the household income-related indicators for the nine regions in Sri Lanka. In line with the regional GDP per capita numbers, households in the Western region recorded much higher income than the other regions. The differences in income inequality as measured by the Gini ratio are varied across the regions. The total income earned by the richest 20% of households is quite larger than the income of the poorest 20% of households as a percentage of total household income. Further, significant disparities in the distribution of poverty levels across the regions can be observed and poverty rates are also consistent with the income inequality distribution among the regions. Overall, sizable gaps in income and poverty are reflected by these socio-economic indicators across the regions.

Table 2.4: Distribution of monthly household income by region

Region	Household Income (US $)	Gini-Ratio	Richest 20%	Poorest 20%	Poverty (Head Count)
Western	500	0.47	53.1	5.0	2.0
Central	313	0.44	49.6	5.0	6.6
Southern	326	0.45	50.9	5.2	7.7
Northern	267	0.48	53.0	3.8	10.9

Eastern	238	0.45	49.8	4.2	11.0
North Western	333	0.47	52.0	4.4	6.0
North Central	285	0.39	44.5	5.5	7.3
Uva	278	0.48	53.8	4.1	15.4
Sabaragamuwa	315	0.46	51.9	5.1	8.8
All Island	357	0.48	52.9	4.5	6.7

Source: DCS (2015)

The structure of the economy has also changed significantly, particularly after the adoption of open market economic policies in 1977. Table 2.1 and Table 2.5 show that the agriculture sector's share of GDP declined while that of the services sector expanded significantly during the post-independence era. The industry sector's share also improved, albeit at a lower rate than the services sector. Among all the sub-sectors in the services sector, the banking sub-sector has played the most significant role in the economic development of Sri Lanka (CBSL 1998). In line with Sri Lanka's economic expansion, the banking sector also expanded in terms of services provided and geographical coverage, while catering to domestic demand in conformity with policy directions given by the regulators. Although the direct value added by the banking sector is captured in the national account compilation, the impact of the banking sector on economic expansion is more broadly based.

Economists have identified the role of the banking sector as: mobilising and mediating domestic and international savings, identifying better investment opportunities by

Table 2.5: Real GDP share by economic sectors (1970–2010)

Economic Sector	1970	1980	1990	2000	2010
1. Agriculture, livestock and forestry	27.1	23.1	21.5	17.7	10.7
2. Fishing	1.2	1.2	1.7	2.7	1.2
3. Mining & quarrying	0.7	3.5	3.0	1.7	2.3
4. Manufacturing	16.7	13.7	17.4	17.4	17.3
5. Electricity, water and gas	0.8	1.1	1.3	1.5	2.4
6. Construction	5.6	5.4	6.8	7.0	6.7
7. Wholesale and retail trade	19.2	19.7	20.5	22.1	23.2
8. Hotels and restaurants	0.0	0.0	0.0	0.7	0.5
9. Transport, storage and communication	9.5	9.4	11.1	11.8	13.9
10. Banking, insurance and real estate	1.2	2.1	5.1	7.6	8.9
11. Ownership of dwellings	3.0	2.8	2.9	1.8	2.8
12. Public administration and defence	3.9	4.9	4.9	4.8	7.6
13. Services (Not elsewhere classified)	11.1	13.1	3.8	3.3	2.4
All sectors	100.0	100.0	100.0	100.0	100.0

Note: GDP classifications have been change in 1982 and 1996 with the base year revisions. Hotels and restaurants sector has been included into the GDP classification in 1996 base year revision.

Source: CBSL (2015b)

minimising information search costs, discouraging investment in unproductive assets, stimulating technological innovations, and improving risk management techniques (Goldsmith 1969; Shaw 1973; McKinnon 1974; Bhattacharya & Sivasubramanian 2003; Ncube 2007; Singh 2008). The outcome of all of these roles paves the way for overall economic expansion. Given that the existing banking system provides a wide array of banking services through the banks' nationwide branch networks, the Sri Lankan economy could be propelled further by improving the efficiency of the banking system and introducing necessary reforms. In formulating future policy reforms, an examination of the past reforms and the evolution of the banking sector with those policy reactions are very important. The next section provides background information for a performance analysis with respect to the efficiency and productivity of the banking sector in Sri Lanka

by explaining the evolution and structure of the financial sector. The next section also highlights banking sector reforms relating to the country's stages of economic expansion.

2.3 Evolution, reforms and the structure of the banking sector in the pre-independence era

The history of the Sri Lankan formal financial sector begins with the establishment of foreign banks in the late 19th century by the British rulers who established British sovereignty and occupied the entire island in 1815. Foreign banks came to Sri Lanka with the boom in the coffee industry, an industry introduced by the British rulers in 1820. A number of foreign banks and agency houses commenced their operations, establishing branches in Sri Lanka catering to the capital needs of the coffee plantation sector (Aponsu 1999).[14] The coffee industry was severely affected by a viral leaf disease in 1880 and production dropped significantly.

This paved the way for collapse of the Oriental Bank Ltd (OBL) resulting in a loss of public confidence in the financial sector.[15] OBL had invested heavily in the coffee industry and was one of only two banks with the authority to issue currency notes during this period. Consequently, to restore public confidence in the financial system of the country, a currency board system (CBS) was established in 1884 and was empowered to

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[14] Snodgrass (1966), as cited in Aponsu (1999), mentions that agency houses became involved in the supervision of plantation crops for a share of the profit until the total debt was paid by the plantation company. Loans were taken by the plantation sector against "coffee mortgages", the expected future harvest from the coffee plantation (Aponsu 1999). The first two domestic banks, namely the "Bank of Kandy" and "Bank of Ceylon" were established in 1828 and 1841 respectively. Both banks failed shortly after their inception.

[15] Public confidence in the banking sector was affected by the collapse of OBL which was one of the largest banks in Sri Lanka at that time.

issue currency notes by a government act (Aponsu 1999).[16] After establishment of the CBS, the "Hatton bank" started in 1888 and was able to capture relatively large customers based in the plantation sector and it operated over a longer period. The "Hatton bank" was the first domestic bank to operate over a significant period as two domestic banks started in 1828 and 1841 were short lived.

The British government introduced political reforms in 1931 through a new constitution granting universal adult franchise.[17] Existing foreign banking institutions focused only on plantation sector needs, and so in 1934 the government appointed the Ceylon Banking Commission (CBC) to make necessary recommendations to improve the financial infrastructure of the country for broad-based economic development (CBSL 1998). As per a recommendation made by the CBC, the Bank of Ceylon was established in 1939 as a private and government partnership. The role entrusted to the Bank of Ceylon at its inception was the expansion of banking services, including the non-plantation sector, to meet the diversified demands of the emerging economy. The Bank of Ceylon achieved this goal before independence, expanding branch networking into nine cities and capturing a diversified customer base.

At independence there were nine foreign banks and two domestic banks in the country, while the money supply was managed by the CBS. The first democratically elected government after independence in 1948 took the necessary steps to establish the CBSL in order to meet the growing needs of an expanding economy. Financial sector

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[16] Paper Currency Ordinance no.32 of 1884.

[17] Universal Adult Franchise was granted as per the recommendation made by the Donoughmore Commission for constitutional reform in Sri Lanka which was established in 1927.

development in the post-independence era began with the establishment of the CBSL in 1950. The CBSL replaced the CBS, as the apex body of the financial system of   Sri Lanka.[18] There was a gradual increase in banking penetration arising from government intervention in the banking industry with the establishment of government, commercial and specialised banks.

2.3.1   Expansion in the banking sector with state intervention (1950–1977)

At independence the banking sector was catering to 3.5% of the population and policy makers were focused on expanding its outreach (CBSL 1998). Accordingly, efforts were taken to reposition the banking sector in order to address the borrowing needs of different sectors of the economy rather than focusing solely on the plantation sector. Special attention was given to improving long-term lending facilities for entrepreneurs. In 1952 amendments to the Bank of Ceylon Ordinance were introduced to enable engagement in long-term development lending and the Development Finance Corporation of Ceylon (DFCC) was established in 1956.[19] These are examples of steps taken to expand the economy through banking sector developments.[20]

Banking sector reforms were formulated within the existing financial framework

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[18] Policy makers identified a number of weaknesses in the CBS regarding the handling of monetary policy (CBSL 1998). The credit supply could not be changed according to economic needs due to the automatic link maintained between the level of reserves and currency. Further, the link established between the   Sri Lankan rupee, Indian rupee and pound Sterling was weakened due to the agreement between the IMF and the Indian government to maintain a gold par value for the Indian rupee.

[19] In 1952 an exemption was given to the Bank of Ceylon from the 10% reserve requirement by amending the Bank of Ceylon Ordinance. In addition, this amendment allowed the Bank of Ceylon to engage in long-term development lending.

[20] In line with these developments the first World Bank mission to Sri Lanka also highlighted the need for a dedicated financial institution for development lending. As per the direction given by the World Bank mission, the DFCC was established by a special act of parliament as a dedicated bank to provide long-term development finance and other necessary services for investors. The DFCC was formed as a limited liability company with joint participation of the domestic private sector, the state sector and foreign stakeholders.

inherited from the British rulers until a new left-leaning coalition government came to power in 1956. The new government adopted nationalisation policies, and the institutional framework of the financial sector of the country was expanded with significant state intervention in the financial sector. The Bank of Ceylon was nationalised and a new state-owned commercial bank, the "People's Bank of Sri Lanka" was also established in the early 1960s.[21] The People's Bank was established by merging the rural banks belonging to the cooperative societies of the country, with the aim of fulfilling the credit needs of the rural sector, particularly for agricultural activities which lacked assess to finance. In line with this state intervention in the banking industry, the CBSL introduced re-financing facilities to commercial banks which provided credit facilities to primary sectors.

The government's desire to lift the economy to a higher growth path by addressing the financial demands of the primary sector of the economy was reflected in this array of financial reforms. In addition, the Finance Act of 1961 also enacted a law to limit the expansion of foreign banks within Sri Lanka in terms of branches and Sri Lankan customers.[22] This enabled domestic banks to improve their customer base by using their monopoly power while avoiding competition from foreign banking institutions. As a result of this government intervention in banking business, the Bank of Ceylon and the Peoples Bank of Sri Lanka were able to expand their branch networks by extending their services to the rural sector.

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[21] The Finance Act of 1961 passed by the Sri Lankan parliament was a landmark in the Sri Lankan banking sector, resulting in the nationalisation of the Bank of Ceylon which had been established in 1931 as a private bank.

[22] Aponsu (1999) highlighted this as an encouragement for foreign banks to form joint ventures in the banking sector with local investors.

Private sector participation improved with the adoption of liberalised economic policies by the new regime which came into power in 1965. Although these liberalisation attempts were not successful enough to eliminate state intervention into the financial sector, two private commercial banks, namely the "Commercial Bank of Ceylon Ltd"[23] and the 'Hatton National Bank (HNB)[24]', were established in 1969 and 1970 respectively.

The new coalition government which came to power in 1970 gave high policy priority to import substitution and self-sufficiency, and government banks were compelled to allocate more resources to the primary sector, particularly agriculture, while mobilising rural sector savings. The branch network of the state banks expanded rapidly during the period 1970 – 1977 with the aim of allocating more resources to the primary sectors of the economy. The banking sector recorded exponential growth in lending and deposit mobilisation throughout the country during this period dominated by the two state-owned banks the Peoples Bank and the Bank of Ceylon. State sector institutions involved in industrial production also borrowed heavily from the state-owned banks. Therefore, the private sector enterprises, including SMEs involved in industrial production, were discouraged due to the asymmetric market conditions and government intervention in industrial production for the domestic market. The role played by the private sector in the banking industry was limited from 1960 to 1977 due to high government intervention in the financial sector of the country through regulatory amendments and the establishment of state-owned banks. Government intervention created a relatively favourable

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[23] In 1969 the first privately owned local commercial bank the "Commercial Bank of Ceylon Ltd" was established through acquisition of three foreign banks, namely the "British Bank', "Easter Bank" and some branches of "Mercantile Bank Ltd".

[24] The HNB was established in 1970 with the amalgamation of the Hatton Bank and Grindlays Bank.

environment only for state-owned banks and as a consequence the number of foreign banks declined to eight by the end of 1976.

The wave of nationalisation during this period also moved to other financial sectors such as insurance and provident funds, resulting in the establishment of state ownership and monopoly power. In 1961 the government established the Insurance Corporation of Sri Lanka (ICSL) in line with their policy framework for nationalisation. The Control of Insurance Act no.25 of 1962 provided monopoly power over the life insurance industry to ICSL. Further, the main social security fund in Sri Lanka, the Employee Provident Fund (EPF), was established in 1961 to fill the lacuna in the social security net for employed people. Low private investment in the financial sector due to state intervention led to the deterioration of the performance of financial institutions due to a lack of competition for resources during this period (Edirisuriya 2007). This provided the necessary justification for liberalising the financial sector in Sri Lanka within the framework of open market economic policies by the new government which came to power in 1977. The next section will evaluate financial sector developments and reforms introduced by policy makers to improve the performance of the financial sector to foster economic growth in an era of open market economic policies after 1977.

2.3.2 Banking sector expansion under the open market economy (1977–2013)

By 1977 the banking sector comprised the CBSL, seven foreign commercial banks, four domestic commercial banks, two development banks for long-term lending, the National Savings Bank (a fully state-owned specialised bank) and the rural banks managed by the cooperatives. Except for the seven foreign commercial banks and the two private

commercial banks, all other banks were controlled by the government. This oligopolistic market structure of the banking sector with public sector dominance did not provide a favourable environment for improving efficiency and competition in the banking industry.

Reforms in the financial sector were aimed at repositioning the banking sector to cater to the government's export-oriented economic development strategy. Accordingly, the Sri Lankan currency was devalued to reflect trade competitiveness and in 1978 a managed floating exchange rate system was introduced with control over international capital flows. The current account was partially liberalised and all the commercial banks were allowed to start foreign currency banking units (FCBUs) to meet the demand for the expected momentum in foreign trade. The prohibition on entry of new foreign banks which had prevailed since 1961 was removed and foreign commercial banks were encouraged to establish branches in Sri Lanka. Having the most open economy and financial sector in South Asia, Sri Lanka attracted a large number of foreign financial institutions in the late 1970s and early 1980s.[25] Although foreign banks entered the banking sector, their operations were limited to the major cities.

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[25] Three foreign commercial banks namely Banque Indosuez, Citi Bank NA and Bank of Credit and Commerce International established branches in Colombo in 1979. Another 7 foreign commercial banks entered the Sri Lankan banking industry in 1980. These were American Express, Bank of Oman, Overseas Trust Bank, Bank of America, European Asian Bank, Habib Bank, A.G Zurich and Algemeine Bank Netherlands. The Bank of Oman changed its name to Mashreq Bank in 1993. The Bank of America closed its operations in Sri Lanka in December 1986. The European Asian Bank merged with Deutsche Bank AG and changed its name to Deutsche Bank AG. In 1991 Algemeine Bank Netherlands amalgamated with AMRO bank. Three more foreign commercial banks, namely Dubai Bank, Union Bank of Middle East and AMRO Bank entered the banking industry in 1981. During 1982 one commercial bank, the Middle East Bank Ltd, was established in Sri Lanka. Branches of the Dubai Bank were acquired by the Union Bank of Middle East in 1983. Later in 1988 the Union Bank of Middle East Ltd was acquired by Hatton National Bank, a local domestic commercial bank. Middle East Bank Ltd was acquired by the Muslim Commercial Bank, a domestic commercial bank in 1994.

With the expansion in the economy, the two fully state-owned domestic commercial banks gave priority to corporate-sector customers while moving away from-grass root level customers in the agriculture and SME sectors. Further, most of their services were concentrated in the capital city of Colombo and other urban areas. The establishment of 17 Regional Rural Development Banks (RRDBs) in 1987 with capital provided by the CBSL was also an effort to address the gap in financial services between the Western region and other areas.[26] In the late 1980s, identifying the growing demand for financial services in the country, two private local banks were also established.[27] Although the private local commercial banks adopted information technology into their operations, state-owned banks were not ready for IT penetration. Therefore, common infrastructure development in the banking sector was limited during this period. The CBSL was vested with more powers, particularly for bank supervision and regulation, by the Banking Act 1988 passed by parliament.

By 1990, six local commercial banks and 18 foreign commercial banks were operating in the country. In addition, one savings bank, 17 regional banks (RRDBs), three development banks, three merchant banks and a number of small cooperative banks were also in the banking industry.[28] Despite the continuation of open market economic policies for more than a decade with financial sector reforms, private banks were not in a position

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[26] A new light was shed into regional development after the establishment of a provincial council system in 1987.

[27] Two private banks, namely Sampath Bank Ltd and Seylan Bank Ltd, were established in 1987 and 1988 respectively. This was the first domestic private investment in the commercial banking sector. Today, both banks perform well under open market economic policies covering all the regions.

[28] In 1997, these 17 RRDBs were merged as six regional level banks. In 2010 these six regional level banks were merged into one national level bank and designated as the Regional Development Bank.

to compete with the state-owned banks which operated as an oligopoly and were supported by a favourable regulatory environment relative to that of the private banks.

Although the government was concerned about improving banking sector efficiency, and despite the privatisation of state-owned enterprises during the 1990s, the privatisation of state banks was not on the agenda. However, in line with the privatisation of other state-owned institutions, directions were issued to the state banks on the need to make necessary provisions for non-performing advances (NPA) as a restructuring initiative. A major reason for the exclusion of banking sector privatisation was trade union action against it (CBSL 2000). Other than that, the government also used state banks as a tool for resource allocation into priority sectors such as agriculture, small industry and regional development. Despite the changed political regime in 1994, the momentum for banking sector expansion continued into the 1990s with the gradual expansion in banking services and the entry of new players into the banking sector. Four domestic commercial private banks and three foreign banks entered into banking business during the period 1990–2000.[29] As mentioned in the manifesto of the newly elected government in 2005, three specialised banks were established by the government catering to the financial needs of the SME sector, which at this time accounted for 70% of employment generation and 18.5% of the country's value added production (Gunaratne 2008).[30] A new bank, Amana

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[29] Between 1992 and 1997 two local private commercial banks, namely the Union Bank and Pan Asia Bank, were established, while three foreign commercial banks also entered the banking industry. These three foreign banks were the Public Bank Berhard, Korea Exchange Bank and Societe Generale. In1997 a new savings bank, the SANASA Development Bank, was started as an investment of SANASA which is a federation of small scale thrift and credit cooperative societies. SANASA is an abbreviation of *Samupakara Nayadena Samithiya* (a credit cooperative society). In 1999 another local commercial bank, the Nations Trust Bank, was established with the acquisition of the Overseas Trust Bank, a foreign bank branch operating in Colombo.

[30] Two specialised banks, the SME Bank and Lankaputhra Bank, were established to address the credit needs of small, medium and micro industries. Another specialised bank, the Sri Lanka Savings Bank Ltd,

Bank Ltd, was established in the post-conflict period as an Islamic commercial bank catering to the needs of the Muslim community. After the end of armed conflict in mid-2009 all banks showed a tendency to expand their branch networks. In addition, various regulatory and monetary policy measures were implemented by the CBSL in the post-liberalisation period to maintain stability and improve the efficiency of the banking sector. The details of the major monetary and regulatory measures taken during the period from 1979 to 2014 are summarised in Table 2.6.

Table 2.6: Major banking sector reforms since 1979

Year	Reform/Direction
1979	Restrictions on the entry of foreign banks into Sri Lanka and branch network expansion of existing foreign banks were relaxed. Commercial banks were allowed to open FCBUs.
1981	The Central Bank of Sri Lanka started to use open market operations (OMO) and statutory reserve requirements (SRR) to control the money supply.
1982	Ceilings on credit for the purchase of real estate or immovable property were removed.
1983	Ceilings on credit for non-priority sectors were removed.
1987	Limits on commercial bank certificates of deposits (CDs) were removed.
1988	The CBSL was empowered with more regulations and controls over the banking sector in Sri Lanka by the Banking Act 1988.
1991	Directions issued by the CBSL to make provision for non-performing advances of state-owned banks and rescheduling their loan portfolios.
1992	Establishment of a loan recovery mechanism for commercial banks and disclosure requirements.
1993	Establishment of a Repo market as a measure to fix the lower end of the call money market.
1999	Single borrower limit fixed to 30% of bank's capital recorded in the previous year annual financial accounts.
1994	Permission granted to issue international credit cards to commercial banks.
2000	The limit on foreign ownership of local commercial banks was increased to 60% of shares.
2002	The lower limit on SRR was removed. Prudential norms introduced for domestic banks were extended to offshore banking units.

was also established in 2008 to improve micro finance and commercial credit facilities while mobilising savings in the country. The SME bank later merged with the Lankaputhra Bank.

Table 2.6: Major banking sector reforms since 1979

Year	Reform/Direction
2003	The risk-weighted capital adequacy ratio was fixed at 10% for banks.
	The CBSL started to determine the SRR on a daily basis for commercial banks.
2006	A direction was issued by the CBSL for all banks to publish quarterly accounts.
2007	The CBSL issued directions to limit single share ownership in commercial and specialised banks to between 10% and 15%.
2008	Directions were issued on commercial and specialised by CBSL to adapt the standardised approach for credit risk and market risk while the basic indicator approach for operational risk in assessing banking sector risk under Basel II.[31]
	With the aim of achieving a sound and healthy banking sector, directions on corporate governance for the banking sector was issued by the CBSL covering responsibility and accountability of the board of directors in banking business.
	Branch opening in the Western region was restricted and permission was only granted to open a branch in the Western region for a bank which opened two branches in other regions to expand the geographical distribution of the bank branch network.
2010	Started a special loan scheme "Awakening the North" to provide required funds for the development of the conflict-affected Northern region with a concessionary interest rate.
	An insurance scheme was implemented to cover customer deposits of the commercial banks, specialised banks and registered finance companies under the Banking Act, direction no. 6 of 2010
2011	Guidelines for mobile payment were issued by the CBSL with the aim of regularising and monitoring mobile payments.
	A licence was issued to the first Muslim commercial bank "Amana Bank" which was to operate-on Islamic principles.
	A draft on Advanced Approaches on Operational Risk under Pillar I of Basel II was issued to all banks enabling them to be familiar with risk management and governance practices in relation to operational risk.
	A loan scheme was introduced in the Northern and Eastern regions to facilitate the repair of houses damaged during the armed conflict.

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[31] Basel I and II are the set of international banking regulations established by the Basel Committee on Bank Supervision. Basel I is the first international regulatory accord which provided a framework for bank supervision with the assessment of capital adequacy of banks. Extending the Basel I framework, Basel II incorporates credit risk of assets held by financial institutions in determining regulatory capital adequacy.

Table 2.6: Major banking sector reforms since 1979

Year	Reform/Direction
2012	The CBSL announced more flexibility in the exchange rate and limited market intervention in the future through a quantity-based strategy instead of the previous price-based intervention strategy.
	The second phase of the loan scheme "Awakening the North" started. It aimed at further enhancing the funding facilities for development of conflict-affected areas.
	A consultation paper was issued to all commercial and specialised banks to ensure that they were maintaining adequate capital requirements to cover their exposure to all risks under Pillar 2 of the Basel II framework.
2013	Commercial banks were permitted to invest in International Sovereign Bonds issued by the Government of Sri Lanka
	The SRR was reduced from 8% to 6% enabling banks to expand their credit disbursements.
	A Direction on Pillar 2 of Basel II on banks to maintain capital adequacy above the minimum regulatory capital requirement was issued to cover their exposure to all risks.
	A consolidation plan of the financial sector was announced by the CBSL to reduce the number of small banking and finance companies. The plan aimed at improving the resilience and stability of the financial sector.
2014	With the aim of minimising the NPA during a period of plummeting gold prices, a credit guarantee scheme for pawning the advances of banks was introduced.
	The CBSL issued directions for the implementation of the liquidity coverage ratio in line with the Basel III Liquidity Standards.

Source: Annual Reports, Central Bank of Sri Lanka (various years)

2.3.3 Branch expansion and outreach of the banking sector

Until the early 1960s financial services for rural areas were provided by the thrift societies and cooperative banks which did not have direct links with the CBSL. After government intervention in the banking industry which established state-owned commercial banks, branch expansion of the commercial banks was used as a means of allocating credit to rural areas with the aim of achieving broad-based economic growth and development (CBSL 1998). Table 2.7 shows that the number of bank branches of commercial banks increased threefold from 1960 to 1970. This was completely due to the expansion of the

branch network of state-owned banks which were established in the early 1960s. Restrictions were imposed on the expansion of foreign commercial bank operations during this period (CBSL 1998).

Table 2.7: Distribution of number of bank branches (1960–2010)

Bank Type	Year					
	1960	**1970**	**1980**	**1990**	**2000**	**2010**
Commercial banks	45	165	503	740	1080	2549
Domestic	28		486	717	1042	2329
Foreign	17		17	23	38	220
Specialised banks	2	10	80	176	294	600
Population (millions)	9.90	12.52	14.75	17.01	19.10	20.65
Banking density	0.5	1.4	4.0	5.4	7.2	15.2

Note: Post-office units maintained by domestic and foreign banks are also included in data.

Source: CBSL (1998), Aponsu(1999),Seelanatha(2007) & CBSL Annual Reports(various years)

During the 1970–1980 period the government expanded the branch network of the state-owned banks to improve the availability of credit in rural areas as a part of its economic development strategy. The objective of the government was to allocate more resources to the primary sector (particularly agriculture) and industry to encourage import substitution for self-sufficiency. Credit guarantees were given, especially for agricultural credit in rural areas, to foster agriculture production. An aggressive effort to mobilise deposits was also made by the state-owned banks through their widely spread branch networks. Banking density, defined as the number of bank branches per 100,000 people, improved significantly during this period due to branch expansion.

In the 1980s the number of branches continued to increase with economic expansion. Government intervention in branch expansion was not so significant after economic liberalisation compared to the pre-liberalisation period (CBSL 1998). However, branch expansion during this period was also driven by the state-owned banks with limited

expansion by the private and foreign banks. Therefore, expansion in the banking sector during this period can be considered as a combination of "demand following" and "supply leading" as explained in the mainstream literature (Robinson 1953; Patrick 1966). With the aim of providing a conducive environment for the expansion of private domestic banks in Sri Lanka, the government discouraged the further expansion of the state-owned banks' branch network in the 1990s. This strategy worked well and new private banks came into the industry while existing private banks expanded their branch networks and service volumes. In 2002, private sector commercial banks exceeded state-owned banks in terms of their share of banking assets (Hemachandra 2013).

The number of commercial banks doubled during the 2000–2010 period, and all banks were now treated equally by the regulators. Figures 2.4 and 2.5 show the gradual expansion of commercial and specialised bank branch numbers and the improvement in banking density from 2006 to 2012. State-owned banks largely contributed to this expansion by pursuing the government's objectives of regional development and by assisting the revival of livelihoods in the Northern and Eastern regions in the post-conflict era. Some foreign banks which maintained a limited number of branches also expanded their branch networks during this period to exploit the comparative advantage of banking in conflict-affected areas, for example from the inflow of foreign funds for reconstruction activities and new customers.

Figure 2.4: Increase in the number of bank branches (2006–2014)
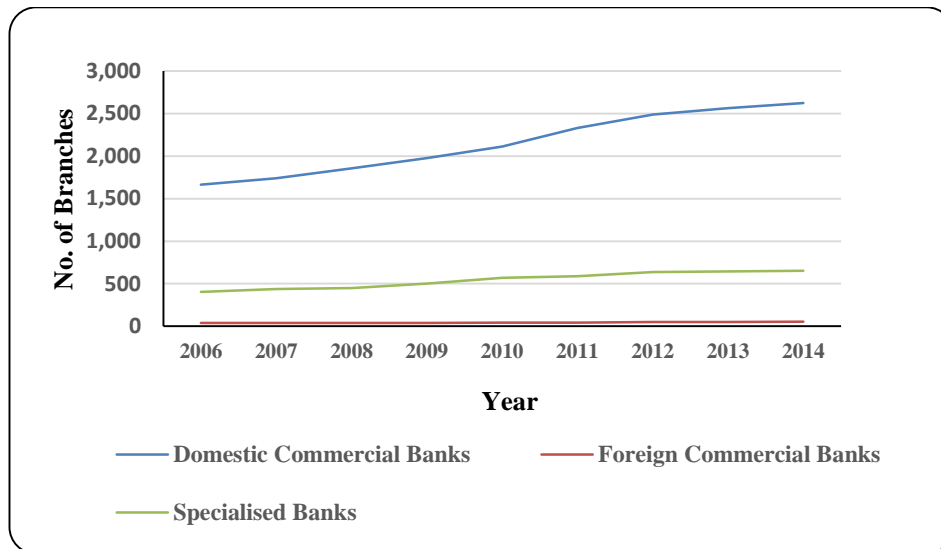
Source: Author's calculations based on CBSL (2015b)

Figure 2.5: Improvements in banking density (2006–2014)

(Bank Branches per 100,000 people)
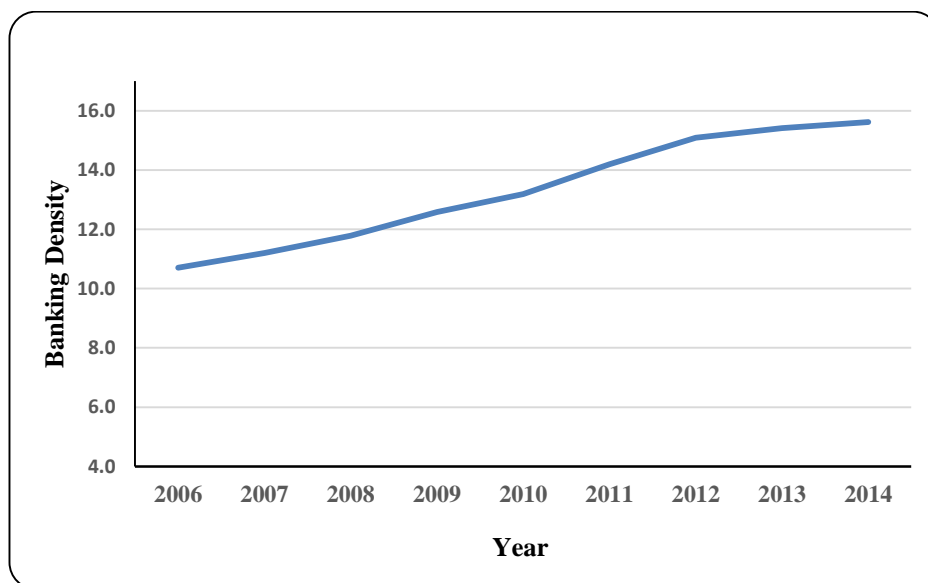
Source: Author's calculations based on CBSL (2015b)

However, bank branches were highly concentrated in urban areas, particularly in the Western region, since all the commercial banks and specialised banks showed a tendency to expand their branch network in urban areas. Despite the continuous expansion in branch networking for all the banks in Sri Lanka, differences in banking penetration

between the Western region and other regions prevailed for a long period of time (Hemachandra 2015). This reflected the greater demand for banking services in urban areas, which resulted in a higher concentration of banking businesses and a further increase in regional economic disparities across the regions. As a policy measure to minimise disparities in banking services the CBSL issued a directive in 2008 to all commercial and specialised banks in Sri Lanka to open two bank branches in other regions when they opened one bank branch in the Western region (CBSL 2013b; 2013c). This policy direction influenced the geographical expansion in bank branch networks in Sri Lanka.

The ending of armed conflict in 2009 significantly improved accessibility to the Northern and Eastern regions, adding momentum to an expansion of the banking industry in Sri Lanka. A number of banks expanded their branch networks in these two regions to take advantage of pent-up demand for banking services for resettlement, reconstruction and expansion in economic activities.

During the period of conflict, significant regional disparities in banking services in terms of accessibility and services provided prevailed, with the Northern and Eastern regions recording the poorest banking penetration. In the post-conflict period, with the expansion in bank branch networks, the conflict-affected Northern and Eastern regions recorded the second- and third-highest banking penetration by the end of 2014. The significant improvement in banking density at the regional level in the post-conflict era is shown in Figure 2.6. Although the banking sector can improve regional growth, the extent of its contribution to regional economies is dependent on the degree of efficiency with which the banking sector operates (Lucchetti et al. 2001; Koetter & Wedow 2010). High banking

institution efficiency at the regional level stimulates regional growth by minimising the cost of funds and improving regional investment (Lucchetti et al. 2001; Koetter & Wedow 2010). Therefore, banking sector efficiency at the regional level is important for inclusive and broad-based economic growth as well as the sustainability of this growth, including that of banking institutions in the long run. On the other hand, inclusive growth through branch/geographical expansion of the banking sector could be ineffective if regional disparities in banking efficiency prevail among the regions in Sri Lanka.

Figure 2.6: Improvements in banking density by region (2006-2014)
(Bank Branches per 100,000 people)
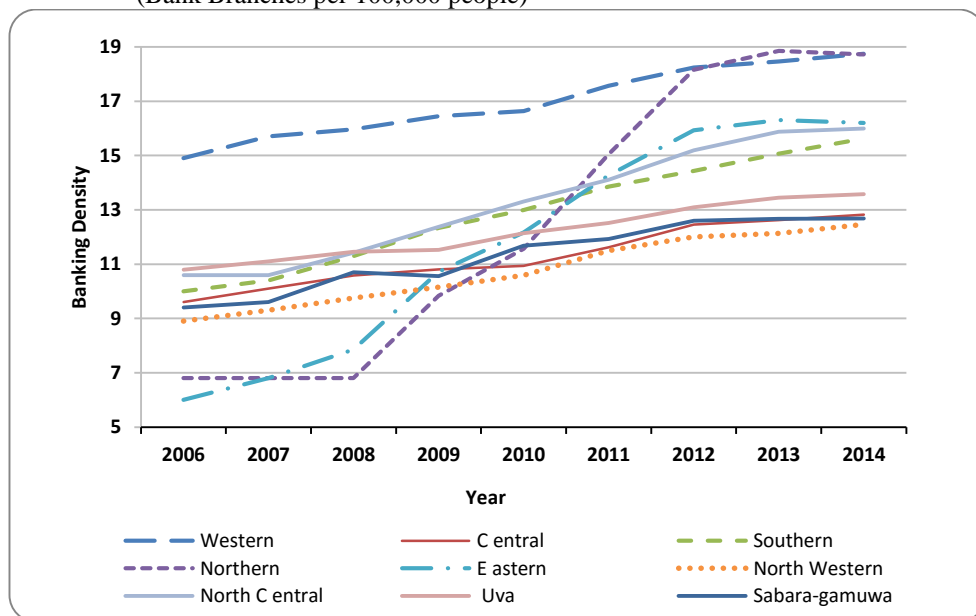
Source: Author's calculations based on various publications of the CBSL

In addition to the distribution of branch networks, banking sector structural indicators, such as deposits, loans, non-performing loans and investments, also showed considerable change during the banking sector liberalisation period. Banking sector efficiency is also dependent on these indicators and is discussed in the next section.

2.3.4 Changes in banking sector indicators

During the last decade the banking sector in Sri Lanka has demonstrated resilience to external and internal economic shocks, while maintaining a positive contribution to the economic growth of the country (CBSL 2014). Economic expansion and innovation have not only changed the institutional structure but also the structure of the financial flows of the banking industry. Therefore, trends in banking sector variables such as advances, investments and deposits also provide useful information about the performance of the banking sector. This section presents the trends of banking sector related variables in Sri Lanka.

The structure of deposits is important for the banking sector since banks have to balance long-term advances with short-term liabilities. The volume of banking sector deposits recorded significant growth after the country adopted open market economic policies. Figure 2.7 shows recent changes in the deposit structure of the banking sector. It clearly indicates a decline in savings deposits and an increase in time deposits due to an increase of the interest rate for time deposits compared to the interest rate on savings deposits.

Structural changes can also be observed in banking assets during this period. Figure 2.8 illustrates the decline in advances as a percentage of total assets of the banking sector around 2009 and then subsequent expansion in the post-conflict era. The Sri Lankan banking sector recorded higher rates of non-performing loans in the 1980s and 1990s arising from inefficiency and political interference in state-owned banks, a poor regulatory environment and problems in corporate governance (Seelanatha 2007). The rate of NPAs declined significantly during the period 2000–2014 as a result of the

Figure 2.7: Structural changes in the deposits of the banking sector (2000–2014)

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Figure 2.8: Structural changes in advances and investments of the banking sector (2000–2014)

prudential regulations introduced by the regulators (CBSL 2012a; 2014). As indicated by

Figure 2.9, NPAs increased rapidly during the global financial crisis period but recovered

in later years. After the ending of the armed conflict, the financial sector in Sri Lanka was

repositioned for expansion of the economy through improving the stability and

productivity of the banking sector. The next section explores the present structure of the

financial sector in Sri Lanka while paying special attention to the banking sector. This will provide the platform to discuss key contemporary issues facing the banking sector in later sections of this chapter.

Figure 2.9: Changes in net non-performing advances of the banking sector (2000–2014)
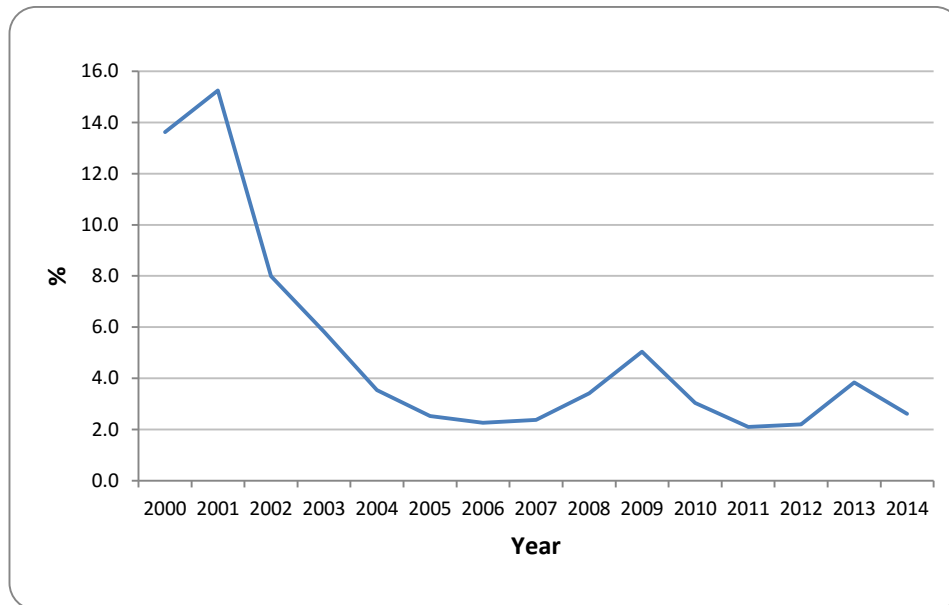
Source: Author's calculations based CBSL Annual Reports (various years)

2.4   An overview of the contemporary financial sector

As in other countries, the financial sector of Sri Lanka is comprised of both formal and informal sectors. Banking institutions dominate the formal financial sector while other markets such as the capital market and money market play a limited role in facilitating the efficient and effective allocation and deployment of resources in the economy. In contrast, the informal financial sector does not have an organised setup and mainly provides short-term lending facilities based on personal contacts. Studies have found a significant role played by the informal sector as a source of credit for consumption loans to poor households (CBSL 2005). This section provides a holistic overview of the structure of the formal and informal sectors of the financial sector while highlighting the role of each player in the sector.

2.4.1 Banking sector financial institutions

The banking sector dominates the financial sector in Sri Lanka. It controls most of the financial flows and possesses most of the financial assets. Economic reforms introduced after independence from the United Kingdom in 1948 brought structural change in the financial sector with the establishment of government banks to provide banking services to all segments of Sri Lankan society (CBSL 1998). Figure 2.10 shows the current institutional structure of the financial sector of Sri Lanka. The banking sector comprises the Central Bank of Sri Lanka, licensed commercial banks, licensed specialised banks, merchant banks, cooperative banks and some other thrift societies.

Central Bank of Sri Lanka

Financial sector developments in the post-independence era started with the establishment of the CBSL in 1950, the apex body of the financial system of Sri Lanka. The CBSL was set up in place of the CBS by the Monetary Law Act no.58 of 1949, with the broad objective of enhancing economic growth through creating an active monetary policy regime and dynamic financial sector. Prior to the establishment of the CBSL central banking functions were handled by the CBS which was established by the Currency Ordinance no.32 of 1884. The core objectives of the CBSL are specified as being the maintenance of price stability and financial system stability for the economic prosperity of the country. Central banks use their monetary instruments, mainly SRR and OMO, to maintain price level stability which is conducive to economic development. Financial system stability is maintained through an effective regulatory

Figure 2.10: Structure of the financial services sector

Financial Services Sector

Informal Sector

Money Lenders

Friends and Relatives

Consumption Credit from Retail Shops

Other Informal Credit

Formal Sector

Central Bank

Banks

Commercial

Private Banks

Foreign

Domestic

Government Banks

Specialised Banks

Private Banks

Government Banks

Rural Banks

Thrift and Credit Co-operatives

Finance Companies

Leasing Companies

Primary Dealers

Contractual Savings Institutions

Provident Funds

Insurance Companies

Venture Capital

Unit Trusts

Money Brokers

Other Institutions

Source: Author's classification

environment, a reliable payments and settlements system, efficient financial markets and sound financial institutions. Financial sector supervision is a vital role played by the CBSL in maintaining financial sector stability in the country. Financial institutions come under the supervision of the CBSL and their shares in assets and liabilities are shown in Table 2.8.

Banking sector

There are 25 licensed commercial banks and seven licensed specialised banks operating in Sri Lanka. Out of the 25 commercial banks, two are fully owned by the government while the domestic private sector and foreign parties own 10 and 13 respectively. Most of the private domestic banks entered the market after the policy reforms of 1977. These reforms encouraged private sector participation in the provision of financial services.

Table 2.8: Total assets and liabilities of the institutions in the financial sector at the end of 2012

Institutions	Assets		Liabilities(a)	
	Rupees bn.	% Share	Rupees bn.	% Share
Central Bank of Sri Lanka	1357.4	15.4	n.a.	n.a.
Financial Institutions Regulated by the Central Bank				
Demand Deposit Taking Institutions				
Licensed Commercial Banks	4207.4	47.8	2927.2	77.6
Other Financial Institutions				
Licensed specialised Banks(b)	708.8	8.0	539.2	14.3
Licensed Finance Companies(b)	428.4	4.9	232.4	6.2
Primary Dealers	128.5	1.5	n.a.	n.a.
Specialized Leasing companies	135.6	1.5	n.a.	n.a.
Institutions not Regulated by the Central Bank(c)	1842.2	20.9	74.2	2.0

(a) Excluding Central Bank of Sri Lanka's liabilities.
(b) Licensed specialised Banks and Licensed Finance Companies are not allowed to accept demand deposits and only accept other types of deposits such as fixed deposits, savings deposits or investment type deposits of customers.
(c) Institutions not regulated by the Central Bank of Sri Lanka include Rural Banks, Thrift and Credit Co-operative Societies, Employees' Provident Funds, Insurance Companies, Stock Broking Companies, Unit Trusts/ Unit Trust Management Companies, Market Intermediaries that include Underwriters, Margin Providers, Investment Managers, Credit Rating Agencies and Venture Capital Companies.

Source: CBSL (2012b)

Although some foreign banks were already established before independence was achieved in 1948, most large foreign banks, such as the Hong Kong and Shanghai Banking Corporation (HSBC), entered into the market in the early 1990s with the shift in government policies that provided equal opportunities for private sector as well as for state sector-owned banks. The 25 commercial banks are allowed to do all banking activities such as deposit taking, granting loans, forex transactions and dealing with derivatives. The seven specialised banks are mostly focused on savings and development banking rather than commercial banking activities. These specialised banks are not allowed to accept demand deposits, which are not entitled to receive interest payments from the banks. Five of the specialised banks are owned by the government while the remainder is a private domestic bank. The CBSL is the regulator of both commercial banks and specialised banks. Its role involves conducting on-site and off-site supervision of these institutions. Merchant banks are established by the commercial banks and they cater to the specific banking needs of their corporate customers and to the demand for financial services in the capital market. There are six merchant banks operating in the country today. The market share and regional coverage of the commercial and specialised bank branches are presented in Table 2.9.

Cooperative banks and thrift/credit cooperative societies also accept deposits and grant credit in the country, catering in particular for the poor and lower middle class households to meet their savings and credit needs. These institutions, focusing on rural development, are regulated and supervised by the Ministry of Cooperative Development which was established to enhance regional economic conditions and development. Although cooperative banks and thrift/credit cooperative societies cater to a large number of

households, they account for less than 2% of total banking sector assets due to the small scale of their transactions.

Table 2.9: Market share and geographical coverage of the banks in Sri Lanka at end 2014

Bank	Ownership type	Business type	Total assets (US$ mn)	Market Share as % of assets	Regions									
					Western	Central	Southern	Northern	Eastern	North Western	North Central	Uva	Sabaragamuwa	Western
1. Bank of Ceylon	State-owned	Commercial	10,179	18.99	■	■	■	■	■	■	■	■	■	■
2. People's Bank	State-owned	Commercial	7,864	14.67	■	■	■	■	■	■	■	■	■	■
3. Commercial Bank of Ceylon	Private	Commercial	6,094	11.37	■	■	■	■	■	■	■	■	■	■
4. National Savings Bank	Private	Specialised	5,970	11.14	■	■	■	■	■	■	■	■	■	■
5. Hatton National Bank PLC	Private	Commercial	4,417	8.24	■	■	■	■	■	■	■	■	■	■
6. Sampath Bank PLC	Private	Commercial	3,309	6.17	■	■	■	■	■	■	■	■	■	■
7. HSBC	Foreign	Commercial	3,099	5.78	■	■								
8. National Development Bank	Private	Commercial	2,012	3.75	■	■	■	■	■	■	■	■	■	■
9. Seylan Bank PLC	Private	Commercial	1,910	3.56	■	■	■	■	■	■	■	■	■	■
10. Nations Trust Bank PLC	Private	Commercial	1,218	2.27	■	■	■	■	■	■	■	■	■	■
11. Standard Chartered Bank	Foreign	Commercial	956	1.78	■									
12. DFCC Bank	Private	Specialised	856	1.60	■	■	■	■	■	■	■	■	■	■
13. DFCC Vardhana Bank PLC	Private	Commercial	776	1.45	■	■	■	■	■	■	■	■	■	■
14. Regional development Bank	State-owned	Specialised	706	1.32	■	■	■	■	■	■	■	■	■	■
15. PABC	Private	Commercial	610	1.14	■	■	■	■	■	■	■	■	■	■
16. Indian Bank	Foreign	Commercial	469	0.88	■		■							
17. Union Bank of Colombo	Private	Commercial	375	0.70	■	■	■	■	■	■	■	■	■	■
18. Deutsche Bank AG	Foreign	Commercial	315	0.59	■									

Table 2.9: Market share and geographical coverage of the banks in Sri Lanka at end 2014

Bank	Ownership type	Business type	Total assets (US$ mn)	Market Share as % of assets	Regions									
					Western	Central	Southern	Northern	Eastern	North Western	North Central	Uva	Sabaragamuwa	Western
19. Sanasa Development Bank	Foreign	Specialised	311	0.58	■	■	■	■		■	■		■	■
20. Axis Bank Ltd.	Private	Commercial	280	0.52	■									
21. Amana Bank Ltd.	Foreign	Commercial	267	0.50	■	■		■		■	■			■
22. HDFC	State-owned	Specialised	264	0.49	■									■
23. Citibank, N.A.	State-owned	Commercial	263	0.49	■									
24. SMIB	Private	Specialised	232	0.43	■		■	■	■		■			■
25. Indian Overseas Bank	Foreign	Commercial	220	0.41	■									
26. ICICI Bank Ltd.	Foreign	Commercial	167	0.31	■									
27. MCB Bank Ltd.	Foreign	Commercial	127	0.24	■		■		■					
28. State Bank of India	Foreign	Commercial	126	0.24	■	■								
29. Habib Bank Ltd.	Foreign	Commercial	76	0.14	■	■			■					
30. Lankaputhra Bank	State-owned	Specialised	66	0.12	■									■
31. Public Bank Berhad	State-owned	Commercial	46	0.09	■		■							
32. MBSL Savings Bank Ltd.	Foreign	Specialised	21	0.04	■		■		■		■	■		■

Note: Sri Lanka Savings Bank is not included due to unavailability of financial statement for the year 2014. According to the 2013 financial data, market share of the Sri Lanka Savings Banks is 0.14% of the banking sector. Empirical analysis in Chapter 5 is based on unbalanced data set of 33 banks including Sri Lanka Savings Bank.

Source: Author's calculations based on financial highlights of all the banks

2.4.2 Non-bank financial institutions

In general, financial institutions which collect deposits from the public are considered to be banks, and non-bank financial institutions are not allowed to accept deposits from the public. In practice, it is difficult to distinguish between the financial services provided by banks and non-bank financial institutions since there are a number of similarities in the services that they provide. Differences can be seen in practices, regulatory environments and legal or formal definitions of the non-bank financial institutions in different countries. In the Sri Lankan context, some non-banking institutions such as finance companies and leasing companies supplement the banks by providing financial services in segments of society which are not reached by the banking sector. Some non-banking institutions compete with banks in the provision of financial services. Other non-banking institutions such as contractual savings institutions and primary dealers mostly concentrate on their specialised sectors and enjoy the advantages of specialisation. This section provides a brief review of the financial services provided by non-banking institutions in Sri Lanka.

Finance and leasing companies

Finance companies also accept short-term, medium-term and long-term deposits from the general public and maintain diversified loan portfolios while offering higher returns to their depositors than either the licensed commercial banks or licensed specialised banks. There was a significant increase in the number of finance companies after economic liberalisation in 1977, with most of the funds invested in higher purchase and leasing businesses (CBSL 1998). There were 72 finance companies registered with the CBSL at the end of 1989. The CBSL introduced new reforms including stringent regulations to ensure the viability of finance companies after some of them failed in the 1980s. The new

regulations led to a decline in the number of finance companies to 24 by the end of 1996. With economic expansion after the end of the ethnic conflict in 2009, the CBSL allowed expansion in this sector, issuing new licences to meet the increasing demand for financial services in the economy. Simultaneously, the CBSL introduced the Finance Business Act, no 42 of 2011 to improve the regulation and supervision of finance companies and to ensure stability of the financial sector in Sri Lanka. Today there are 46 finance companies operating (CBSL 2015a).

In addition to commercial banks, specialised banks and finance companies, specialised leasing companies are also engaged in leasing activities. Unlike commercial banks, specialised banks and finance companies, these specialised leasing companies are not permitted to accept deposits from the general public. Specialised leasing companies have been engaged in leasing activities since the early 1980s and currently there are 7 of them operating in the country. The CBSL has been vested with powers to regulate and supervise specialised leasing companies by the Finance Leasing Act no.56 of 2000.

Unit Trusts

With the expansion of the capital market, the Security Exchange Commission of   Sri Lanka (SEC) issued four licences to establish unit trust in 1992 as a strategic move aimed at stimulating the security market, creating a new way of attracting savings into the capital market. Unit trusts are governed by the SEC as specified in an act passed to establish the SEC and the unit trust code. Although the contribution of unit trusts to the capital market in Sri Lanka is not significant, they contributed to changing the way savings are mobilised in the capital market (Seelanatha 2007). There are 35 unit trusts currently established in

Sri Lanka. Out of these, 33 are operated as open-ended funds and the other two are closed. The investment portfolios of unit trusts consist mainly of equity and government securities.

Contractual savings institutions

The two main categories of contractual savings institutions, namely social security funds and insurance companies, also play a vital role in the financial market in   Sri Lanka with their ability to accumulate significant amounts of long-term saving from the public. Social security funds in Sri Lanka comprise the Employees' Provident Fund (EPF), the Employees' Trust Fund (ETF), the Public Service Provident Fund and some other provident funds run by semi-government entities or private sector employers. EPF dominates social security funds as the largest fund in terms of member accounts, assets and investments.[32] The minimum contribution of the EPF should comprise 8% of the gross salary of an employee and 12% from the employer totalling 20% of gross earnings of the employee. From its inception in 1961 EPF has invested mainly in government securities. Currently 97% of the EPF's portfolio is invested in treasury bills, bonds and rupee loans while 3% is invested in the Colombo Stock Exchange (CSE).

The ETF is the second-largest social security fund in Sri Lanka.[33] ETF was established in 1981 to enhance the stock ownership of employees. Although most of the features of the EPF are also included in the ETF, members are allowed to withdraw their money upon

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[32] The EPF has 2.3 million active member accounts, 11 million inactive member accounts and 900 (20% of GDP) billion rupees of accumulated assets which account for 12.2% of financial sector assets in   Sri Lanka (CBSL 2012b). The EPF is supervised by the Ministry of Labour and managed by the Central Bank of Sri Lanka.

[33] The ETF has assets of 153 billion rupees (CBSL 2012b). The ETF is supervised and managed by a board of trustees appointed by the Ministry of Finance and Planning.

termination of employment. Further, membership is open to people in self-employment and the ETF provides health insurance to its members. The ETF contribution, 3% of the employee's salary, is financed by the employer if the member is not self-employed. The ETF invests mainly in government securities which account for 80% of its current investment portfolio. The government also maintains a social security fund called the Public Sector Pension Scheme, an unfunded, non-contributory pension scheme for civil servants and other government employees. In addition, some Approved Private Provident Funds are maintained by private and semi-government institutions, with finance provided by employers and employees. These contractual savings institutions contribute to the economic development of the country through their investments and provide social security schemes for the workforce of Sri Lanka.

The insurance industry is also a leading player in the economy for mobilising savings and improving investment. The introduction of the coffee and tea industries by the British rulers provided the ingredients for establishing the insurance industry. Therefore, the insurance industry dates back to the pre-independence era. In the beginning the insurance industry comprised only foreign companies and the first   Sri Lankan insurance company, the "Sri Lanka Insurance Company" was established after the Company Act of 1938 was passed. Later, a number of private sector players entered into the insurance business by establishing companies to provide insurance services. In 1961 the government established ICSL in line with their policy framework for nationalisation. The Control of Insurance Act no.25 of 1962 provided monopoly power of the life insurance industry to ICSL.

After the economic reforms of the late 1970s, the government established a second state-

owned insurance company in 1981 with the objective of improving services through increased competition. To encourage private investment in the insurance industry, the Control of Insurance Act no.25 of 1962 was amended in 1986. An expanding economy and legislative provisions paved the way for a gradual expansion in the insurance industry. At present there are 21 insurance companies operating in the country and the Insurance Board of Sri Lanka (IBSL) was established under the Insurance Industry Act no.43 of 2000 as the regulator and supervisory body of the insurance industry. The insurance industry in Sri Lanka accounts for only 3% of total financial sector assets of the country but has huge potential for rapid expansion, due to the low penetration of insurance services compared to the situation in other lower middle-income countries (AIR 2014).

Primary dealers

Primary dealers play a significant role in the money market in Sri Lanka, particularly in the government securities market, having exclusive rights vested in them for purchasing government securities at primary auctions. Investors can invest in government securities, namely treasury bills and treasury bonds, through these primary dealers. The main objectives of a primary dealer system are: to maintain stable demand for government securities, provide liquidity to the secondary market, provide intermediary services for investing in government securities, and improve market information about government securities. The CBSL is the regulator of primary dealers who are appointed under the Local Treasury Bills Ordinance, No 8 of 1923 and the Registered Stock and Securities Ordinance no. 7 of 1937. Most domestic commercial banks are active in the government security market and in establishing primary dealers companies. In 2014 the total assets of

all 15 primary dealer companies was 191 billion rupees, accounting for 1.6% of total financial sector assets in Sri Lanka.

2.4.3   Informal financial sector

As in other developing countries, the informal financial sector is also an important component in Sri Lanka's financial sector. Although there is no well-established definition for the informal or unorganised financial sector, in general the informal financial sector consists mainly of money lenders, pawn brokers, and friends and relatives who provide financial assistance with or without collateral and interest. Findings of the Consumer Finances and Socio Economic Survey (CFS) conducted by the CBSL in 2003/04 recorded that the credit provided by the above informal sources accounted for 18% of the total borrowings of the household sector in Sri Lanka. Further, rural retail shops in Sri Lanka also have a practice of providing consumption items on credit to their customers without any collateral (CBSL 2005).

2.5   Contemporary issues in the Sri Lankan banking sector

This section explores recent developments in the banking sector of Sri Lanka and the latest policy initiatives taken to address major issues relating to the banking sector. The possible impacts of those policy initiatives on banking sector efficiency and productivity are also discussed. The contemporary issues highlighted in this section are: consolidation of the banking sector, action to manage risk in the banking sector, competition, and branch expansion.

Consolidation

In 2009 some Sri Lankan finance companies faced liquidity problems due to the collapse of related companies, in line with the domestic and global economic downturn. With the past experience of a collapse of 13 finance companies in 1989–1990 and the failure of one specialised bank in 2002, policy makers were concerned about the stability of the financial sector. Therefore, a Master Plan on the Consolidation of the Financial Sector for improving the stability and strength of banking and non-banking institutions was presented by the CBSL in early 2014.[34] Under this consolidation plan, small banks and non-bank financial institutions were encouraged to merge with other banking institutions and/or non-banking institutions, with the aim of improving their liquidity and capital to enhance their resilience to economic shocks. Further, it was expected that consolidation in the banking and non-banking institutions would help them to adhere to regulatory requirements imposed by the CBSL. During the post-conflict period the CBSL issued a number of directives to banks and non-bank financial institutions regarding adherence to capital requirements and risk assessments as recommended by Basel II. In addition, corporate governance practices were expected to improve with the consolidation process and with adherence to the CBSL's directives on the corporate governance of banks and non-bank institutions.

Financial sector institutions mostly use consolidation as a strategy to maintain growth, survive in a competitive environment and gain competitive advantage, operate with

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[34]The Guidelines on Taxation in terms of the Inland Revenue (Amendment) Act no. 8 of 2014 and Value Added Tax (Amendment) Act no. 7 of 2014 on tax incentives to support the consolidation process were approved by the Monetary Board. Further, these two acts were enacted by the parliament, giving effect to the budget proposal on financial sector consolidation.

economies of scale, expand geographical coverage and minimise business risk.[35] Although policy makers expect that mergers and acquisitions will improve efficiency and productivity in the financial sector, there is no consensus among economists as to the outcome of mergers and the time taken to manifest the effects of mergers (Rhoades 1993; Calomiris 1999; Amel et al. 2004). Efficiency gains from consolidation could be dependent on a number of factors including the efficiency of those institutions in the pre-merger period, management quality, market conditions and size. Since the proposed consolidation process is highly focused on the improvement of stability, less attention has been paid to possible changes to the efficiency and productivity levels of the banks and non-bank institutions in the post-merger period. Therefore, policy makers should be concerned about changes in the efficiency levels of banking institutions in the process of consolidation.

Risk and capital adequacy

Sri Lanka adopted Basel I in 1993 for the licensing of commercial banks in line with their recommendations on capital adequacy. Basel I focused mainly on credit risk and commercial banks were required to adhere to risk measures including that of capital adequacy. With the aim of strengthening the resilience of the banking sector, the CBSL implemented capital directives requiring all banks to adopt Pillar I of Basel II in early 2008. Pillar I of Basel II consists of a standardised approach to credit risk, market risk and a basic indicator approach to operational risk. The current capital adequacy requirement imposed on the commercial banks of Sri Lanka is 10% and core capital

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[35] Consolidation can be defined as combining two or more institutions to form one new institution to achieve a specific objective or meet an agreement.

should not be less than 5%. Over the post-conflict period banks were directed to improve their internal management and information systems to cope with Basel II and III.

One of the expected benefits from the envisaged consolidation of the banking sector is to provide the necessary financial strength for small banks and non-bank financial institutions to adopt the required measures on risk as recommended by the Basel II and III. Although the ultimate objective of all these improvements in the financial sector is to steer Sri Lanka toward achieving economic development, the impact of a higher focus on risk measures on banking efficiency has not been discussed. Empirical studies of the banking sector have argued that any attempts at controlling financial sector risk could dampen the performance of the financial institutions, including their productivity and efficiency (Chiu & Chen 2009; Sun & Chang 2011). Therefore, policy makers should consider the possible trade-off between banking performance and the intensity of actions required for stabilising the banking sector in order to avoid the negative impact of over-regulation.

Competition

As mentioned in previous sections, financial liberalisation after 1977 encouraged private sector participation in the banking sector. Competition among banking institutions was enhanced by the liberalised regulatory environment, particularly after deregulation of interest rates on deposits and advances. Continual increases in the number of players in the banking industry and in the numbers of branch networks of some banking institutions further intensified this competition. This competition contributed to an improvement in banking services, procedures, instruments, technology and service quality, and spread to

the grassroots level in Sri Lanka (Hemachandra 2013). In general, economists argue that more competition in the banking sector encourages banks to reduce the prices of their financial services. Despite the competitive environment prevailing in the banking sector, the difference between the lending rate and deposits rate (margin of cost of funds) is still at a relatively higher level in Sri Lanka. The higher cost of funds prevailing despite the competitive banking environment could be due to the impact of inefficiency in the banking sector. Although there are 25 commercial banks operating in Sri Lanka, foreign banks mainly serve their corporate customers in Colombo or selected cities.

In general, domestic private banks also focus on high net worth customers in cities whereas the state-owned banks have a broader customer base which includes poorer segments of the society. This segmentation of customer bases is also reflected by the geographical distribution of branch networks, since state-owned banks cover more rural areas than private and foreign banks. Accordingly, these characteristics in the banking sector could lead to lower efficiency due to less competition in credit demand. Therefore, improvement in bank efficiency could be a remedial measure for reducing the cost of funds in the banking sector so as to achieve the envisaged higher economic growth (Koetter & Wedow 2010).

Branch expansion

During the period of armed conflict, the Northern and Eastern regions recorded the poorest banking density (i.e. the lowest numbers of bank branches per 100,000 population) among the nine regions in Sri Lanka. However, in the post-conflict period most of the banks expanded their services to the conflict-affected Northern and Eastern

regions, which recorded the second- and third-highest banking densities by the end of 2012, while the banking density of the other regions improved only moderately. Although the banking sector improves regional growth, the extent of the banking sector's contribution to regional economies is dependent on the degree of efficiency with which the banking sector operates (Koetter & Wedow 2010). High banking institution efficiency stimulates regional growth by minimising the cost of funds and improving investment. Therefore, banking sector efficiency at the regional level is important for inclusive and broad-based economic growth, as well as the long-run sustainability of banking institutions. On the other hand, inclusive growth through branch/ geographical expansion of the banking sector could be ineffective if regional disparities in banking efficiency prevail among regions in Sri Lanka. A comparative analysis of banking efficiency among regions, and identification of underpinning factors of low efficiency, would be useful for the formulation of regional policies to achieve broad-based, inclusive and sustainable growth.

2.6 Summary

This chapter has examined the development of the banking sector in Sri Lanka in terms of banking services, branch networks, outreach and regulatory reforms, while explaining the structure of the economy and financial sector. The evaluation of banking sector expansion clearly indicates that financial liberalisation has positively contributed to a favourable environment for the banking industry. Under liberalised market conditions, growth momentum of the banking sector has been maintained by competition. Banking institutions have expanded their banking products and services in a competitive environment created by banking sector reforms. In addition to regulatory reforms, more

recent developments in financial infrastructure have also contributed to banking sector expansion in Sri Lanka. Although expansion of the banking sector was moderate, with government intervention in the financial sector, some government policies for branch expansion contributed to a mitigation of regional disparities and improvement in financial inclusion in the country.

Some contemporary issues in the banking sector were also discussed in this chapter and the impact of these issues on the efficiency and productivity of the Sri Lankan banking sector was discussed. Among them, the consolidation plans and risk measures for stabilisation of the banking sector could be considered as the core contemporary issues in the banking sector, while competition and branch expansion should also be considered for the further development of the banking industry.

The financial sector's contribution to the real economy has come through the improvement in financial depth in Sri Lanka after the regulatory reforms started in 1977. Therefore, the financial sector's contribution to the national economy could be further enhanced through improving the efficiency and productivity of the banking industry. If the efficiency and productivity of the banking sector could be improved at the regional level, this would help address issues of broad-based economic growth and inclusiveness in Sri Lanka's economic development strategy and in achieving the country's long-term economic prosperity.

It is important to review the literature in the area of banking efficiency and productivity to develop a suitable framework for analysing banking sector efficiency of Sri Lanka.

Therefore the next chapter summarises the literature on banking efficiency and productivity and highlights the influence of other factors on efficiency and productivity. It also identifies areas in which the literature is limited and areas in which there are gaps in the literature.

Chapter 3   Review of the literature on banking efficiency and productivity

3.1   Introduction

This chapter explores the empirical literature on banking efficiency and productivity. It also highlights the factors which influence the efficiency and productivity of banking institutions. Most of the literature examines changes in the efficiency and productivity of banking institutions based on a comparison of descriptive statistics of efficiency scores and productivity indices. Some studies extend their analysis to identify the factors influencing efficiency and productivity using multivariate modelling. Generally, both parametric and non-parametric methods have been used in the literature to evaluate and compare the efficiency and productivity of financial institutions. DEA and SFA are the most widely accepted and commonly used non-parametric and parametric methods, respectively, for evaluating the efficiency of financial sector institutions, including banks. Prior to the establishment of modern techniques such as DEA and SFA, financial ratios were the most common measures used for estimating the efficiency of the banking sector.

Productivity indices are also used to disaggregate changes in total factor productivity, thereby providing a solid foundation for comprehensive policy formulation to improve banking sector productivity. Total factor productivity of the financial sector has been evaluated in the literature by using a number of productivity indices.[36] A review of the literature on efficiency and productivity is provided under five main sections in this chapter. Section 3.2 provides an overview of the literature on banking sector efficiency

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[36] The Malmquist productivity index is the most popular one while the Hicks-Moorsteen index and Luenberger productivity index have also been employed in many studies (Kenjegalieva & Simper 2011; Sufian 2011b; Das & Kumbhakar 2012).

and productivity studies. Literature on the impact of bank-specific factors on efficiency and productivity is reviewed in Section 3.3 followed by Section 3.4 which reviews the literature on the impact of the business environment on bank efficiency and productivity. The literature which highlights the impacts of macroeconomic factors and socio-demographic factors on efficiency and productivity is reviewed in Sections 3.5 and 3.6 respectively. Section 3.7 explores the literature on the importance of banking efficiency and productivity on economic growth, followed by summary in Section 3.8.

3.2   Overview of the literature on bank efficiency and productivity

In finance and accounting studies, the performance of a firm is usually measured based on different monetary aspects such as profitability, level of capacity utilisation, capital adequacy and liquidity. From the economist's point of view however, the multi-dimensional production process of a firm should be evaluated by efficiency and productivity measurements based on the production frontiers of that particular firm or decision-making unit (DMU), focusing upon the relationship between inputs and outputs. Arising from theoretical developments in measuring efficiency through production frontier methods in the 1950s, academics and policy makers began to evaluate the performance of manufacturing firms through these modern efficiency indicators. Although efficiency and productivity analysis using frontier methods was initially limited to the manufacturing sector, the application of the frontier method in measuring efficiency in the services sector was later augmented by the theoretical development of ways to measure intangible outputs.

Sharmen and Gold (1985) were the first to investigate banking efficiency using the

frontier method. With the development of new methodologies for measuring firm efficiency, there was an unprecedented growth in articles pertaining to the analysis of efficiency in the banking sector. Initially, academics and policy makers in the area of banking efficiency focused on the US and European banking sectors due to the availability of quality data (Berger & Humphrey 1991; Berger et al. 1993; De Guevara & Maudos 2002). Although studies of the efficiency of banking in developing countries were less prevalent in the past due to a lack of data, more recent studies have evaluated the banking efficiency of these countries after they introduced significant financial reforms (Hasan & Marton 2003; Das & Ghosh 2006; Drake et al. 2006; Sahoo & Tone 2009; Sufian 2009b; Barros et al. 2011; Arjomandi et al. 2012; 2014). With these reforms the banking sector in most countries experienced increased competition, ownership changes and market penetration.

Accordingly, a large number of studies have been published on the impact of competition, ownership changes and market penetration on banking sector efficiency (Al-Muharrami et al. 2006; Ataullah & Le 2006; Kasman & Yildirim 2006; Zajc 2006; Vu & Turnell 2010). In addition, the impact of some macroeconomic factors on efficiency has also been evaluated in the literature (Kasman & Yildirim 2006; Chan & Karim 2010). However, the relationship between socio-demographic characteristics and banking efficiency has only been explored in a limited number of studies (Berger et al. 1997; Battese et al. 2000; Berger & De Young 2001; Cebula et al. 2011). This study presents a review of the literature under four sub-sections based on the main focus of efficiency analysis. An outline of the review of previous studies in this chapter is given in Figure 3.1.

Figure 3.1: Literature highlighting the factors influencing banking performance

Literature on the determinants of banking efficiency & productivity

Bank-specific factors
(branch expansion, ownership type, mergers etc.)

Business environmental factors
(liberalisation, regulatory reforms, competition, risk etc.)

Macroeconomic factors
(GDP, inflation etc.)

Socio-demographic factors
(population density, education level etc.)
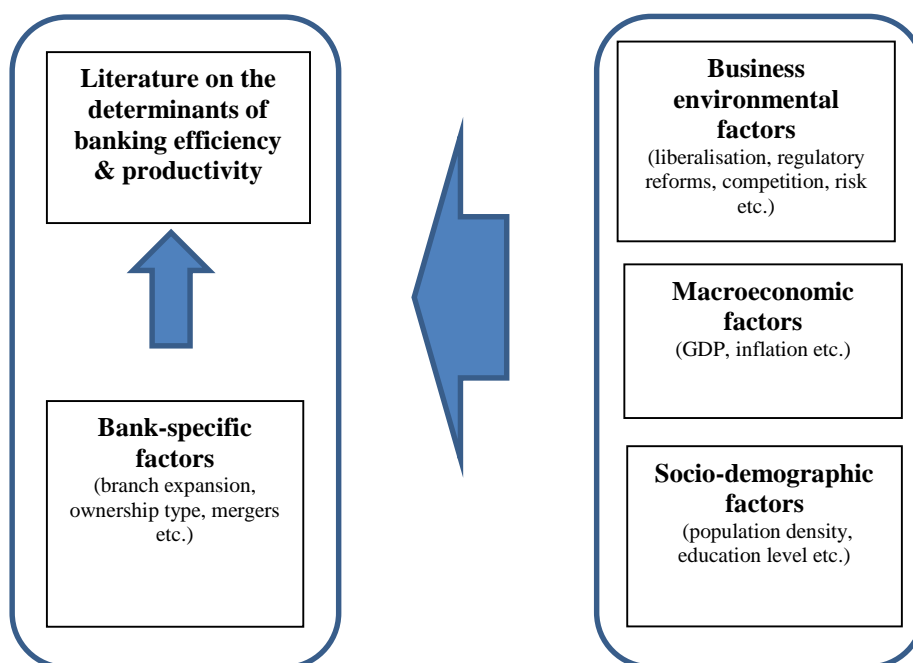
Source: Author's classification

The literature review is presented in four categories based on the types of factors influencing efficiency as highlighted in previous studies. The influential factors categorised as "bank-specific factors" are mostly dependent on the internal environment and these factors are dependent on the decisions taken by the banking institution. The other three categories of factors namely, business environmental factors, macroeconomic factors and socio-demographic factors are mostly dependent on the external environment, which is not controlled by the management of the banking institution. However, categorisation of the factors influencing banking efficiency is a challenge because there is considerable interaction between these factors and there is no established benchmark for the categorisation.

3.3 Impact of bank-specific factors on efficiency and productivity

As mentioned earlier, the bank-specific factors are related to the operations of the banking institutions themselves such as branch expansion, mergers and acquisitions. These factors are mostly dependent on decisions taken by management and the board of directors based upon the powers vested in them. A large amount of literature has evaluated the efficiency and productivity of banking institutions before and after changes in the above factors (Grabowski et al. 1993; Berger et al. 1997; Berger & De Young 2001; Berger 2007; Pasiouras 2008; Sufian 2011b; Ayadi et al. 2013; Halkos & Tzeremes 2013). These factors influencing the efficiency and productivity of the banking sector are specific to the banking institutions rather than the external environment. Based on these findings the literature has suggested remedial measures with respect to bank-specific factors to improve banking efficiency and productivity. The next sub-sections are devoted to reviewing the literature on the impact of bank-specific factors on the efficiency and productivity of banking institutions.

3.3.1 Branch expansion

The geographical coverage of financial institutions in the global economy has continued to improve since the 1990s, with cross-border entry stimulated by deregulation in financial sectors, expansion in international trade, technological developments and increased foreign direct investment (Berger & De Young 2006; Berger 2007). This expansion in geographical coverage has led to an increase in the number of bank branches operated under one bank. Prior to developments in methodologies for efficiency analysis and their application to the measurement of the efficiency of the banking sector, the impact of geographical expansion on banking services was evaluated based on financial

ratios. Nelson (1985) shows that convenient branch location is important for customers and that concentration of banking activity into a limited geographical area does not improve efficiency. He incorporates the impact of branch expansion into the cost function of banks. Based on modern banking efficiency concepts, Grabowski et al. (1993) provides evidence of higher technical efficiency in branch banking organisations than with multi-bank holdings.[37] This study highlights that more autonomy in branches has improved efficiency in the branch banking model. However, this study only compared efficiency in banking organisations with branches and multi-bank holdings without focusing on branch expansion itself.

Extending the literature into branch banking and efficiency, Berger et al. (1997) evaluate the cost efficiency of 760 commercial banks in the US using parametric and non-parametric methodologies. While they accept the negative impact of branching on the cost efficiency of a bank, they argue that over-branching helps to improve the revenue of banking institutions. These finding are in line with Hughes et al. (1996) who show that an increase in geographic diversification through branch expansion could improve the cost efficiency of banks in terms of risk and return based on US data. This was later confirmed by Hughes et al. (1999), who find that the economic benefits of the consolidation of US banks through interstate expansion reduced the macroeconomic risk they encountered.

Deviating from the previous cost efficiency studies based on the US banking sector,

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[37] Multi-bank holdings have separate banks in different states while the branch banking organisations maintain a number of bank branches in different states with one national head office. This investigation was conducted in an environment where banks in the US could expand their branch networks into other states or establish separate banks in different states.

Battese et al. (2000) used Swedish banking sector data to highlight the negative impact of bank branching on technical efficiency. They point to the increase in the number of bank employees due to branch expansion as the main factor underpinning declining efficiency. In another major study based on US data for over 7000 banks from 1993 to 1998, Berger and De Young (2001) find an increase in the efficiency of banks that expanded to nearby regions and states. Profit efficiency and cost efficiency were assessed for this evaluation. Although they find a moderate relationship between distance and efficiency, particularly for small banks, Berger and De Young (2001) argue that the parent organisation could use their superior skills, policies and practices to improve the efficiency of regional level branches and the negative impact of distance could be overcome through this efficiency gain.

Bank expansion drew limited attention as a risk management strategy until Shiers (2002), using US banking data from 1966 to 1996, explained the advantages of bank branching to reduce market risk through geographic diversification. He shows that a reduction of banking risk with geographic expansion works well when economic diversity among the regions exists. Berger and De Young (2006) also show that the negative impact of geographical expansion on profit and cost efficiency on the US banking system was due to deregulation in branch expansion. The Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994, encouraged interstate branching from mid-1997. In addition, Berger and DeYoung (2006) argue that the impact of technological advancement with geographical expansion negates the efficiency decline to some extent. They use data on banks in US multibank holding companies from 1985–1998.

A limited number of studies have focused on branch expansion and banking efficiency in European regions, particularly after the bank mergers of the early 2000s with the establishment of the European Monetary Union. Kroszner (2008) analysed banking sector efficiency in Europe and argued that similar efficiency gains experienced by US banks could be expected from cross border intra-European bank mergers. Kroszner (2008) highlighted the higher profits of US banks with wide geographical spreads until the 1980s, and improvements in the efficiency of the US banking sector after geographic deregulation in 1997 through the reallocation of assets to more profitable banks. Further, Bos and Kolari (2005) calculate the profit and cost efficiency of European and US banks for the period 1995–1999, and conclude that geographic expansion has improved the efficiency gains of large US and European banks. They also mention possible economic motivations in the future for geographic expansion of banking institutions due to this efficiency gain. Based on the Greek commercial banking industry, Pasiouras (2008) also find a positive and significant impact of number of bank branches on technical efficiency over the period 2000–2004.

Among more recent studies on banking efficiency, Vu and Turnell (2010) studied cost efficiency changes in Vietnamese commercial banks due to banking reforms using an SFA Bayesian approach. In this study Vu and Turnell (2010) highlight bank branch expansion as a factor underpinning the slight decrease in cost efficiency of the banking sector over the period 2000–2006. However, a positive impact of branch expansion on the cost efficiency of banks is revealed by Mahathanaseth and Tauer (2014) based on Thai commercial banks after the East Asian Financial crisis.

While US banks expanded their branch networks, there were no incentives for them to outreach into rural areas. European banks have also expanded their geographical coverage mainly through cross-border acquisition of banking institutions (Bos & Kolari 2005; Kroszner 2008). Therefore, it is interesting to evaluate the impact on banking institution efficiency when they enter new geographical areas through the expansion of branch networks without acquisition, merger or liberalisation policies. Accordingly, this study focuses on evaluating the impact of branch expansion on the efficiency of the banking sector in the post-conflict era in Sri Lanka.

3.3.2 Bank ownership type

Gerschenkron (1962) justifies government ownership in strategic economic sectors such as banking, emphasising the necessity of financial services for economic growth in the absence of private participation. In line with this view, La Porta et al. (2002) also highlights importance of government ownership in banking to allow more control over resource allocation and implementation of projects as opposed to regulating banks to try and ensure optimum allocation of funds. They argue that government intervention in financing firms can be used as a strategy to overcome institutional failures and enhance aggregate demand for fostering economic growth. However, the findings of La Porta et al. (2002) based on 92 countries do not find a positive relationship between government ownership of banks and financial sector development. Most of the empirical literature on changes in banking efficiency and productivity across ownership types also finds that foreign and domestic private banks outperform state-owned banks (Altunbas et al. 2001; Demir et al. 2005; Fries & Taci 2005; Berger 2007; Phuong et al. 2015). The higher efficiency of foreign owned banks is mostly found in developed countries. Some studies

which focus on developing countries have found higher efficiency in private banks relative to the state-owned banks (Das & Ghosh 2006; Ray & Das 2010; Arjomandi 2011; Le et al. 2017). Therefore the findings of the empirical studies on banking efficiency reveal the influence of economic environment on efficiency differences between private and state-owned banks.

Studies on banking efficiency and productivity also focus on differences in performance levels between state-owned banks and private banks, with cross-border expansion in foreign banks stimulated by financial sector reforms throughout the world (Hasan & Marton 2003; Havrylchyk 2006; Berger 2007; Lensink et al. 2008; Mamatzakis et al. 2008). Banking sector expansion across territorial borders has also been found to be stimulated by advancements in information technology and ever increasing international trade and financial flows. Berger (2007) argues that parent banks can use their superior skills, policies and practices to improve the efficiency of branches away from headquarters, overcoming the negative impacts of cross broader expansions or distance. This argument is mostly true for developed countries since state-owned banks generally outperform their foreign counterparts in developing countries (Berger & De Young 2001; Berger 2007; Sufian 2009b). The low efficiency and productivity of foreign banks in developing countries are explained as an outcome of poor regulatory environments. The empirical findings against this view support the conclusion that foreign banks are more efficient in developing countries relative to domestic banks, highlighting the higher efficiency in foreign banks as an outcome of exploitation of their comparative advantages (Bhattacharyya et al. 1997; Isik & Hassan 2002; Hasan & Marton 2003; Grigorian & Manole 2006; Zajc 2006).

The differences in banking performance across ownership categories is also explained by agency theory, as separation of ownership from control is a common issue with respect to the banking sector. Altubas et al. (2001) find that lower efficiency in state-owned banks is a result of inadequate financial market discipline due to the low intensity of shareholder pressure. In the absence of financial market discipline, management decisions of state-owned banks can be based on their personal agendas or political influences. Therefore, many studies have proposed improvements in corporate governance practices as a strategy to alleviate the agency problem by introducing better controls and effective monitoring of management (Shleifer & Vishny 1997; Johnson et al. 2000; Becht et al. 2003; Barth et al. 2006; Bokpin 2013). According to the literature reviewed with respect to bank ownership it is very clear that differences in banking efficiency between ownership categories are underpinned by the inherent characteristics of each ownership category. Therefore, an evaluation of the efficiency-ownership nexus is important for a comprehensive analysis of banking performance in Sri Lanka. The findings of the analysis will also be useful for other countries in the South Asian region, and for other developing countries with similar socio-economic backgrounds.

3.3.3   Mergers and acquisitions

Like most service sector institutions, banks use mergers and acquisitions as a business strategy. Maintaining business growth, surviving in a competitive environment and gaining competitive advantage, operating with economies of scale, expanding geographical coverage and minimising business risk are among the main advantages of merging banking institutions. With the wave of liberalisation in financial sectors throughout the world, some small and medium banks face a challenge of survival, while

big banks are expanding their operations, particularly across territorial boundaries. In this environment, policy makers have encouraged small and medium banks to merge. Acquisition has been used by large banks to enter into a new market and increase their scale of operations while expanding their operations geographically. Mergers and acquisitions have also been stimulated by the integration of financial markets in the world and developments in information technology which have expedited financial flows and enabled monitoring. Although policy makers expect that mergers and acquisitions will improve the efficiency and productivity of banks due to all the advantages mentioned above, there is no consensus on the outcomes of such mergers among economists. Empirical studies on the impacts of mergers and acquisitions on the efficiency and productivity of banking institutions provide mixed results, while some studies support an improvement in efficiency with mergers and acquisition, others do not (Worthington 2001; Sufian 2009b; Kiliç 2011; Halkos & Tzeremes 2013).

Much of the pioneering literature measuring the impact of mergers and acquisitions on banking efficiency is focused on the expected reduction in costs (Berger & Mester 1997; Fried et al. 1999; Amel et al. 2004). Some of the literature has evaluated the impact of mergers and acquisitions based on frontier methods while others have used ratios of profitability such as return on assets (ROA) and interest margins to measure efficiency (Berger & Humphrey 1992; Rhoades 1993; Berger & De Young 1997; Peristiani 1997). Fried et al. (1999) is one of the pioneering studies which evaluated the technical efficiency of mergers and acquisitions using a large sample of 6000 credit unions in the US while considering 300 mergers. The study concludes that the efficiency of member service provisions increased in the acquired credit unions, while the acquiring credit unions

experienced a decline in efficiency. Further, improvement in member service provisions was observed when the two credit unions were different in size before the merger. Worthington (2001) also reveals the positive impact of mergers on the allocative efficiency of cooperative credit unions in Australia. Using multivariate analysis for the period 1993–1997 for a sample of cooperative credit unions Worthington shows that the efficiency of the credit unions increased after mergers.

However Lang and Weizel (1999) find no significant cost efficiency improvement in a sample of German cooperative banks in 1992 during the post-merger period based on a sample of 283 mergers. They estimated the cost efficiency for the period 1989–1997 and the results of the study reveal that banks acquired by large banks were less efficient than other banks of the same size.[38] Ralston et al. (2001) do not find higher technical efficiency in Australian cooperative credit unions involved in mergers during the financial years 1993/94 and 1994/95. Their study does find efficiency gains for less efficient credit unions after a merger or acquisition.

Drake and Hall (2003) further evaluated the scale and technical efficiency of the Japanese banking sector using a cross sectional data set of 149 banks for the financial year 1997. The results show that small banks are more efficient than large banks in terms of their scale of operations. The study highlights efficiency changes in the post-merger period since bank performances are dependent on a number of factors including management quality and specialisation in banking business. Sufian (2004) also evaluated the efficiency of domestic commercial banks in Malaysia during pre- and post-merger periods and the

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[38] Cooperative banks acquired by large banks are less efficient than the other co-operative (non-acquired) banks in the post-merged period.

results of the study confirm an improvement in overall technical efficiency of banks in the post-merger period. Small and medium-sized banks benefited significantly from mergers due to an improvement in scale efficiency. The study was conducted for the period 1998–2003 and covered a number of mergers and acquisitions during this period. Sufian (2009b) further confirms higher total factor productivity for the Malaysian banking sector in the post-merger period using DEA and the Malmquist-productivity index.

However Rezitis (2008) finds a decline in efficiency and total factor productivity for Greek banks that participated in merger activity during the period 1993–2004. He concludes that the decline in efficiency after merging could be attributed to technical inefficiencies and a decline in the scale efficiency of the banks that had merged. Although Kiliç (2011) provides evidence of an improvement in the technical efficiency of Turkish banks after the acquisition of some domestic banks by foreign banks, Kiliç's study points out that other factors such as regulatory measures influenced banking sector performance during the 2002–2009 period.

Among more recent studies on the issue of mergers and efficiency, Ayadi et al. (2013) finds support for convergence of the technical efficiency level of European banks arising from mergers and acquisitions. However, productivity improvement was not significant in the post-merger period. The study used data from 42 banks with merged or acquired transactions and 587 non-merged banks in the 15 EU countries and Norway for the period 1996–2003.[39] The study used the Free Aggregation Hull framework (FAH) developed by

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[39] Countries coming under the EU15 area are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

Green and Cook (2004) to measure technical efficiency and efficiency in choice of input–output mixes. Although the study finds no evidence of efficiency and productivity improvements in merged or acquired banks, an actual convergence of input-output mixes was revealed by the structural efficiency changes.

In line with Ayadi et al. (2013), Halkos and Tzeremes (2013) also evaluated efficiency gains from mergers and acquisitions for the Greek banking sector for the period 2007–2011 using a more advanced DEA bootstrap approach. Their empirical results based on 45 potential (virtual) mergers and acquisitions in the banking sector do not support the view that mergers or acquisitions involving efficient banks result in efficient banking groups. Since there were some operating efficiency gains recorded subsequent to the mergers and acquisitions in 2011, the last year of the reference period, Halkos and Tzeremes (2013) conclude that the Greek financial crisis in the period 2008–2009 would have negated any efficiency gains achieved through mergers and acquisitions.

It should be noted that these studies evaluate the short-run impacts of mergers and acquisitions on the efficiency of the banking sector, although a number of empirical studies have highlighted a lag between consolidation and the realisation of efficiency gains (Rhoades 1993; Berger et al. 1998; Calomiris 1999). There is no agreement in the empirical literature regarding the time taken for the effects of mergers or acquisitions of banking institutions to manifest as it is a challenging task to minimise costs and harmonise management practices in merged institutions. There is only limited evidence of improvement in economies of scale, management quality and cost reduction for larger banks in the post-merger period. Amel et al. (2004) highlights an efficiency increase after

consolidation in small and medium-sized banks with economics of scale, improvement in management and cost reductions.

3.3.4   Other bank-specific factors

There is also evidence from the literature of the importance of the influence of other factors on bank efficiency. Among them, size of the bank has been identified by many studies (Demir et al. 2005; Das & Ghosh 2006; Drake et al. 2006; Burki & Niazi 2010; Andries 2011). The logarithm of total assets is the most common and widely used proxy variable for assessing the influence of bank size on efficiency due to economies of scale. Further, the impact of asset quality on banking efficiency has also been evaluated in the literature mostly using the ratio between fixed to total assets (Chang & Chiu 2006; Pasiouras 2008). In addition to these factors related to the financial performance of banks, management quality has also been identified as a factor influencing banking efficiency. Policy makers are particularly interested in how managerial decisions affect banking performance and how managers cope with risk in banking. Most of the literature supports the existence of a link between management quality and banking sector efficiency and productivity (Berger & Humphrey 1997; Das & Ghosh 2006).

Some empirical studies have focused on assessing the impact of the business environment on banking efficiency, due to the significant interaction between banking efficiency and factors related to the business environment such as market liberalisation, regulatory reforms, competition and risk. The impact of business environmental factors on banking sector efficiency and productivity is discussed in the following section.

3.4   Impact of the business environment on banking efficiency and productivity

Banks operate under different business environments and their operations are also influenced by other players in the banking sector, other financial sectors and other sectors in the economy. Accordingly, the literature has identified the influence of business environment factors such as competition, the structure of the market and the legal and regulatory framework on banking efficiency. Therefore, the influence of the business environment should be considered in evaluating differences in efficiency between banks for the purpose of a comprehensive analysis. This section reviews the literature related to banking efficiency and productivity and the impact of the business environment on them. Financial liberalisation and reforms, competition and risks are among the mostly highlighted possible business environment factors impacting on banking efficiency in the literature with respect to developing countries. These are discussed in the following sections.

3.4.1   Liberalisation and regulatory reforms

In general, the banking sector is one of the most highly regulated sectors in an economy, mainly due to systemic risk linked to the sector's role of having to match short-term liabilities with long-term assets (Diamond & Dybvig 1983; Diamond & Rajan 2001; Song & Thakor 2007). Although regulations are essential for the healthy performance of the banking sector and for economic agents to retain confidence in the financial sector and to achieve more transparency, economists have highlighted the inefficiencies that can arise, in particular, from over regulation. Inefficiency in the banking sector could lead to a slowdown in the economy, since the banking sector plays a major role in resource

allocation.[40] Therefore, deregulation in the banking sector has been introduced by many countries in different economic regimes as a strategy to stimulate the economy.[41] Deregulation involves the elimination, simplification and redefining of the controls on banking operations imposed by regulators or the government, and the introduction of new regulations and supervision which enhance the operations and transparency of the banks while protecting the rights of customers and shareholders. The conventional argument is that an economy can benefit from banking sector deregulation and liberalisation as deregulation reduces the cost of borrowing and improves resource allocation efficiency through market competition.[42]

Efficiency and productivity analyses are widely used by economists to assess changes to banking performance arising from deregulation and liberalisation of the banking sector. Studies on banking efficiency and deregulation initially focused on developed countries since the wave of economic liberalisation only impacted developing countries at a later stage. Although the conventional view is that deregulation and liberalisation improve banking sector efficiency, empirical studies which have investigated the liberalisation-efficiency nexus of the banking sector indicate mixed results.

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[40] The literature discusses changes in banking efficiency and the effect of economic slowdowns, particularly the GFC in 2008 and the East Asian currency crisis in 1997/98. Most literature indicates the need for prudential regulatory measures and comprehensive measures to monitor financial sector performance (Özkan-Günay et al. 2013; Matoušek et al. 2015).

[41] Although deregulation of the financial sector, particularly in developing countries, is backed by international financial organisations such as the IMF, prudential regulatory and supervisory measures are necessary to expand and stimulate the financial sector. The Asian Financial crisis of 1997-98 is a good example of unfavourable economic outcomes from financial deregulations without proper regulatory and supervisory mechanisms.

[42] In practice these traditional arguments in favour of deregulation do not support enhancing banking sector performance in the absence of supervision and the application of financial best practices.

Findings from a number of studies based on the banking systems of the European countries support the conventional view of efficiency and/or productivity improvement subsequent to the implementation of deregulation policies. Berg et al. (1992) is a pioneering study which reveals improvements in the banking sector in the aftermath of banking sector liberalisation in Norway. The study clearly shows efficiency and productivity gains after liberalisation of the banking sector using DEA and the Malmquist productivity index.[43] Zaim (1995) also focused on efficiency gains after financial liberalisation of Turkish commercial banks and finds similar results. The findings of Zaim (1995) are further confirmed by Isik and Hassan (2003) and Demir et al. (2005). Isik and Hassan (2003) find efficiency and productivity gains after deregulation of the Turkish banking sector in 1980. Improvement in the productivity of the Turkish banking sector was derived mainly from efficiency gains rather than technology advancements. A study by Canhoto and Dermine (2003) of Portuguese banks also shows improvement in productivity and efficiency from banking sector deregulation. The study covers the post-deregulation period 1990-1995. During this period the banking sector was allowed to engage in cross-border expansion and for the entry of new players in banking in Portugal. In addition, Hasan and Marton (2003) investigated the impact of liberalisation on the Hungarian banking sector. Their findings also support a positive contribution of liberalisation on banking efficiency.

Among the banking efficiency studies focused on Asia and Oceania, Akhtar (2002) finds evidence of improvement in banking sector efficiency from liberalisation and especially in terms of encouraging the privatisation of the banking sector in Pakistan. Higher

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[43] Berg *et al.* (1992) highlighted increased competition and the entry of foreign banks as being instrumental in improving the efficiency of the Norwegian banking sector.

allocative and technical efficiency was recorded for private banks from a sample of 40 banks. Ataullah and Le (2006) investigated the impact of economic reforms on the Indian banking sector and find the reforms had a positive influence on banking efficiency for the period 1992 to 1996. The findings of Ataullah and Le (2006) are further confirmed by Kumar and Gulati (2009), who find a convergence of the technical efficiency of the Indian banking sector in the post-deregulation period from 1993 to 2006 using alpha-convergence and beta-convergence ratios.

More recently, the results of Kumar (2013) and Das and Kumbhakar (2012) also confirm improvements in the technical efficiency of Indian public sector banks in the post-deregulation period. Xiaogang et al. (2005) investigated the impact of deregulation on the cost, allocative and technical efficiency of Chinese banks. The study covered 43 Chinese banks for the period 1993 to 2000. The results of the study reveal efficiency gains for the banking sector from liberalisation policies implemented in 1995 which provided more autonomy for the Central Bank of China in policymaking and supervision of the banking system. However, Xiaogang et al. (2005) find that efficiency gains had declined four years after the introduction of the liberalisation policies. Xiaoqing et al. (2007) also find a positive impact of deregulation on banking sector cost efficiency for the Chinese banking sector, while Sufian and Habibullah (2011) show that economic freedom has a positive correlation with banking sector technical efficiency.[44] In terms of productivity, Matthews and Zhang (2010) find that no significant improvements resulted from the opening up of the banking industry in China for the period 1998–2007. In Middle East

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[44] The Heritage foundation compiles an index on economic freedom and other sub-indexes such as freedom of business, monetary freedom and freedom from corruption (www.heritage.org/index).

countries, banking efficiency studies based on Egypt and Lebanon also support the existence of a positive impact of deregulation on banking sector efficiency (Turk Ariss 2008; Fethi et al. 2011).

In evaluating the impact of deregulation on the efficiency of the Australian banking sector, Sturm and Williams (2004) find an improvement in efficiency and productivity in the post deregulation period 1988–2001. The study highlights improvement in efficiency as being due to increased competition which was enhanced by deregulation of the Australian banking sector in 1986, which removed all barriers to foreign bank entry. Chen and Lin (2007) also find similar results for Australia after further banking sector reforms in 1998. They show that the overall efficiency of nine domestic commercial banks improved with the reforms.[45]

In a cross country study by Hermes and Nhung (2010), covering four Latin American countries namely Mexico, Argentina, Brazil and Peru and six Asian countries namely India, Pakistan, Thailand, Philippines, Korea and Indonesia, they find a positive impact of financial sector liberalisation on banking efficiency. The sample consisted of 4000 annual observations of banking data, and composite indexes were compiled to measure the degree of liberalisation of each country. Chortareas et al. (2013) also used similar indices to prove a positive correlation between economic freedom and banking efficiency in their study of 27 European Union member states.[46]

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[45] The sample consists of nine domestically owned Australian banks namely Westpac Banking Corporation (WBC , Commonwealth Bank of Australia (CBA), National Australia Bank Limited (NAB), Australia and New Zealand Banking Group Limited (ANZ), Macquarie Bank Limited (MAB), Bendigo Bank Limited (BEN), Bank of Queensland Limited (BOQ), Adelaide Bank Limited (ADB) and St. George Bank Limited (SGB).

[46] Indexes compiled by the Heritage Foundation are also used in this study.

A significant improvement in banking efficiency has not been revealed by studies on the US banking sector after liberalisation of interest rates in the 1980s. Indeed, a decline in productivity of the US banks is found in some empirical studies after the deregulation of interest rates (Humphrey 1991; Humphrey & Pulley 1997; Wheelock & Wilson 1999; Alam 2001; Mukherjee et al. 2001). Berger and Humphrey (1997) explain the decline in productivity as being as a result of competition in the US banking sector, which compelled bankers to pay high interest rates on deposits while keeping fees for deposits at the same level. They argue that while customers benefited from the deregulation, the productivity of banks did not improve. Similar results were observed in the post-liberalisation period for Spain (Grifell-Tatjé & Lovell 1997; Lozano-Vivas 1998). Although Zaim (1995), Isik and Hassan (2003) and Demir et al. (2005) all highlight a positive impact of liberalisation on banking efficiency in Turkey based on recent data, Denizer et al. (2000) and Denizer et al. (2007) find a decline in the efficiency and productivity of the Turkish banking system during the early stages of deregulation in the 1980s.

Deviating from providing clear evidence of a positive or negative impact of deregulation on efficiency and productivity, some studies find both negative and positive outcomes after banking sector deregulation. Ali and Gstach (2000) find a decline in banking efficiency in the period from 1990–1996 after deregulation of the banking sector in Austria, but find an improvement in banking efficiency in the 1996–1997 period. They used DEA and a Malmquist productivity index to measure the performance of banks. Using a similar methodology, Rizvi and Khan (2001) evaluated banking efficiency in Pakistan for the post-reform period 1993–1998. The study reveals an overall decline in

efficiency and productivity during the reference period, with the decline mainly due to a poor performance by foreign banks. However, the study concludes that domestic banks have benefited in terms of improved efficiency and productivity in the post-reform period due to increased competition including competition from foreign owned banks. This study suggests there is a need to adopt a multivariate analysis for evaluating the impact of deregulation on banking efficiency, incorporating all potential factors including that of competition. Among the more recent literature, Bhattacharyya and Pal (2013) find deregulation had a positive impact on the technical efficiency of the Indian banking sector during the initial phase of banking reforms but a negative impact on efficiency at a later phase, based on data for 103 Indian banks from 1989–2009.

Overall, the literature shows a lack of generalisability of findings from studies on the impact of liberalisation and regulatory reforms on banking efficiency and productivity. It seems that the impacts of liberalisation and regulatory reforms on banking sector performance are dependent on country-specific characteristics and other factors. Therefore, in assessing the impact of liberalisation and regulatory reforms on banking sector performance, consideration of country-specific and other factors is important.

3.4.2   Competition

Competition among banks exerts an impact on economic growth, since the banking sector is the backbone of the financial sector of a country. The impact occurs through two main channels. First, greater competition in the banking sector encourages banks to reduce the prices of their financial services and avoid cost inefficiencies. Second, greater competition reduces the monopoly power of banks. Therefore, banks should not be allowed to enjoy monopoly rent in a competitive market environment. Accordingly, an

increase in investment and the resulting expansion in the economy could be expected with a reduction in the cost of funds in a competitive banking environment, since bank credits are the main source of external funding for firms, particularly in developing countries. This would lead to a more efficient allocation of resources and therefore improved productivity and growth for the economy overall.

While, theoretically, the banking sector is expected to improve efficiency by avoiding cost inefficiencies in a competitive environment, the empirical literature on the relationship between competition and efficiency has yielded ambiguous results. In the literature on efficiency and market structure, some studies highlight the impact of banking sector competition on cost efficiency based on the US and European banking sectors (Berger 1995; Goldberg & Rai 1996; Berger & Hannan 1998; Punt & Van Rooij 2003). Most of this literature supports the view that there is a positive correlation between cost efficiency and the market power of banks. Stochastic frontier analysis, a parametric method, has commonly been used in estimating the cost efficiency of the banking sector based on a cost function.

Weill (2004) specifically focuses on the relationship between cost efficiency and competition which is measured by the Rosse-Panzar H-Statistic. As against the intuitive positive influence of competition on efficiency, Weill (2004) reveals a negative relationship between competition and the cost efficiency of the European banking sector for 12 EU countries for the period 1994–1999. The Rosse-Panzar H-Statistic has also been used by Casu and Girardone (2006) to investigate the relationship between technical

efficiency and competition among 15 countries in the European Union.[47] Unlike most

previous studies which focused on competition and efficiency using SFA, Casu and

Girardone (2006) used DEA for the compilation of technical efficiency scores. The results

from this study provide little evidence of a positive relationship between efficiency and

competition. Further, the study argues that improvement in the efficiency of banking

sectors in Europe does not increase with banking competition. Contrary to Casu and

Girardone (2006), Chen (2009) concludes that a positive relationship exists between

efficiency and competition in the banking sector based on 10 Sub-Saharan African

countries. Their study calculated the cost efficiency of 77 banks in 10 Sub-Saharan

African countries for the period 2000–2007, with competition measured using the Rosse-

Panzar H-Statistic.[48]

Pruteanu-Podpiera et al. (2008) investigated the relationship between banking efficiency

and competition for the Czech Republic over the period 1994–2005 using a Granger

causality analysis based on vector auto regressive (VAR) multivariate models. Cost

efficiency estimates of banks were calculated using the Distribution Free Approach

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[47] Two different groups of measures have been used in the literature to measure competiveness in the banking sector. The first group of measures is based on the traditional industrial organisational (IO) approach which assumes that high market concentration causes a less competitive banking environment. Accordingly, competition is measured by concentration indices which are based on market share. The most common concentration index used in the literature to assess market concentration is the Herfindahl-Hirschman Index, which is based on market shares (Herfindahl 1950). The second approach, a new industrial organisational (IO) approach, provides non-structural tests which focus on banking activities directly. The Rosse-Panzar H-Statistic is a commonly accepted non-structural index used in measuring banking sector competition. The Rosse-Panzar H-Statistic is an indicator which provides a quantitative measure of competition in the market (Panzar & Rosse 1987). This measure calculates the elasticity of total revenues with respect to changes in factor input prices based on reduced-form revenue equations. The overall level of competition in the market is captured by these types of equations. Another non-structural measure, the Lerner index, is also used in some banking studies on competition. Unlike the Rosse-Panzar H-Statistic, which gives an aggregate measure for all banks in the sample, the Lerner index can be calculated for each bank in the sample (Lerner 1934).

[48] See Al-Muharrami (2005) for comprehensive analysis of market structure, competitiveness and efficiency incorporating Rosse-Panzar H-Statistic and Herfindahl-Hirschman Index.

(DFA), while the Lerner index was used to measure competition among the banks. The results of the study support the existence of a negative relationship between efficiency and competition in the banking sector. Casu and Girardone (2006) also used VAR models to find the dynamic interaction among efficiency and competition in the banking sector of five European countries namely, France, Germany, Italy, Spain and the United Kingdom. The study used 2701 annual observations to assess the cost efficiency of banks for the period 2000–2005. Study results reveal unidirectional causality from efficiency to competition. According to these findings, improved efficiency can increase competition, whereas the usual assumption is that increased competition improves efficiency.

Although standard economic arguments suggest a positive influence of competition on firm efficiency, recent literature indicates the complexity and ambiguity of these findings. Many countries experience competition in their banking sector after significant financial sector reforms. Therefore, competition in the banking sector is linked to a number of factors including banking sector liberalisation and regulations imposed on the sector.[49] These factors could be region specific, country specific or bank specific. Therefore, recent literature has used a multivariate framework to quantify the impact of competition on efficiency. Further, the literature has highlighted the possible link between competition and banking sector stability which is absolutely essential for the long-term sustainable economic growth of a country.

3.4.3 Risk and uncertainty

The recurrence of financial crises has increased concerns about the stability and possible

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[49] In most instances reforms encourage private sector participation in the banking sector which improves competition among the players in the banking sector.

threats to financial sectors all over the world (Kim & Santomero 1988; Hellwig 2009; Huang et al. 2012). This has stimulated studies about risk related to banking businesses and other financial services. Although the traditional model used in banking efficiency assumes banks to be risk neutral, other studies have identified that exclusion of risk factors from efficiency analysis could lead to incorrect or non-robust conclusions (Laeven 1999). Therefore, more recent studies on banking efficiency have incorporated banking risk as a potential factor which influences banking performance. Two approaches in the literature on banking efficiency can be clearly identified based on how to assess banking risk. One group treats risk as an endogenous factor by forming proxy variables based mainly on non-performing advances and risky assets. The other group treats risk as an exogenous factor by forming proxy variables based on the external environment.

In past studies which have treated risk as an endogenous variable, researchers initially assessed the risk of bank failure based on financial ratios and tried to establish a link between efficiency and risk (Cebenoyan et al. 1993; Barr et al. 1994; Elyasiani et al. 1994). In later studies the quality of credit and bank capital has been widely used as a proxy for risk. Berger and DeYoung (1997) evaluated possible links between cost efficiency, credit risk and bank capital using data for commercial banks in the US covering the period 1985–1994. They argue that inefficient banks may have inadequate risk management systems and low equity capital ratios, while negative shocks from the external environment also reduce efficiency. Further, they suggest a negative relationship between the equity capital ratio and risk. However, risk is basically measured using non-performing advances and the equity to assets ratio of the bank.

Confirming the findings of Berger and DeYoung (1997), Ataullah et al. (2004) also find a negative impact of non-performing advances on the technical efficiency of banks through a comparative analysis of Indian and Pakistani banks covering the period 1988–1998. The quality of loans and/or financial ratios was not incorporated in the assessment of the efficiency of the banks in these studies, since risk was treated as an endogenous factor. The relationship between risk and efficiency was assessed in the second stage, mainly using multiple regression techniques.

Studies which treat risk as an exogenous factor incorporate proxy variables for risk into the calculation of efficiency. Accordingly, Mester (1996) argues that there is a correlation between risk and efficiency in his study based on 214 banks in the third Federal Reserve district of the US.[50] Non-performing advances and capital-to-equity ratios were used as proxies for risk in the calculation of efficiency. Later, Hughes (1999), Hughes et al. (2000) and Hughes et al. (2001) also incorporated risk into the efficiency calculation by introducing a risk component into the production function in an SFA framework. Altunbas et al. (2000) included risk in calculating the efficiency of Japanese banks using data from 1993 to 1996. These studies confirm a negative relationship between financial capital and bank inefficiency.[51] Further, these studies also support the view that non-performing advances have a negative influence on banking sector efficiency.

Deviating from the conventional view of a production function in measuring efficiency,

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[50] The Federal Reserve System consists of 12 regional Federal Reserve Banks and the Board of Governors in Washington, D.C. The third Federal Reserve district covers eastern Pennsylvania, southern New Jersey, and Delaware and is served by the Philadelphia Federal Reserve Bank.

[51] Financial capital mainly consists of retained funds built through accumulated profit, capital provided by shareholders and lenders.

Chang (1999) incorporated banking risk as an undesirable output in measuring the technical efficiency of the Taiwanese banking sector. Drake and Hall (2003) also assessed the risk of undesirable output for 149 Japanese banks where problem loans were used as the proxy for risk. The study concludes that non-performing advances have a significant impact on banking efficiency, particularly in small banks. Girardone et al. (2004) extended the studies of Drake and Hall (2003) and Chang (1999) by incorporating asset quality and non-performing loan variables into a production function in measuring the efficiency of Italian banks for the period 1993–1996. The results confirm a reduction in cost efficiency with the inclusion of risk and asset quality variables into the analysis.

Although non-performing advances and other ratios of risky assets mostly cover only credit risk, banks are also exposed to operational and market risk.[52] Credit risk arises when there are defaults on repayment of debts by creditors. Operational risk is defined as risk arising from fraud, business losses due to a new legal framework, the physical environment and other environmental factors.[53] Good internal control is essential for mitigating operational risk. Risk of decline in the market value of investment is basically defined as market risk. The market value of an investment could be affected by factors such as changes in interest rates, exchange rates and equity.

Therefore, more recent studies have tried to incorporate other banking sector risks such as market risk and operational risk. Among them, Chang and Chiu (2006) assessed the impact of credit and market risks on the efficiency of 26 Taiwanese banks for the period

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[52] In 2001the Basel Committee established a framework (the Basel Accord) for calculating banking sector risk by dividing risk into three parts namely credit risk, operational risk and market risk.

[53] Factors relating to the physical environment such as natural disasters or any other event could reduce the value of physical assets owned by financial institutions.

1996–2000. Their study incorporated undesirable output, namely non-performing advances and volatility in the market capitalisation of the banks, as a proxy for credit and market risk respectively. Findings from the study reveal a negative relationship between risk and efficiency for the banks included in the sample. In addition to credit and market risk, Chiu and Chen (2009) and Sun and Chang (2011) extended their studies by incorporating proxy variables for operational risk. Findings from both studies accept the significance of risk factors on banking efficiency.[54] Chiu and Chen (2009) used a three-stage DEA approach to assess the impact of risk on efficiency, while Sun and Chang (2011) used a heteroscedastic stochastic frontier model introduced by Wang (2002).[55] Sun and Chang (2011) introduced more comprehensive proxies aimed at capturing credit risk, market risk and operational risk. They used the non-performing loan ratio as a proxy for credit risk. Market risk was estimated by the volatility of the exchange rate and interest rate, while stock return volatility and the equity to asset ratio were used to estimate operational risk.

Meanwhile, the impact of risk management of the banking sector in 12 Central and Eastern European (CEE) countries on productivity is identified as the main driver of

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[54]In addition to credit risk, operational risk and market risk, Chiu and Chen (2009) evaluated the impact of some other variables on efficiency using DEA and SFA. Those variables are ownership type, age, loans to capital ratio, size of the banks in terms of assets, economic growth, money supply growth, current account and capital account balances in the BOP. Sun and Chang (2011) used SFA to measure the impact of credit risk, operational risk and market risk on banking efficiency.

[55]In the first stage the efficiency of selected banks was calculated based on DEA incorporating credit risk, operational risk and market risk. In the second stage, inputs were adjusted for the characteristics and environmental variables of banks based on SFA. The variables used to capture characteristics and environment are ownership type, age, loans to capital ratio, size of the banks in terms of assets, economic growth, money supply growth, current account and capital accounts balances in the BOP. In the third stage, based on the inputs adjusted at the second stage, domestic banks' efficiency was estimated using DEA to find the influence of risk on efficiency without controlling the external environment factors.

productivity improvement by Kenjegalieva and Simper (2011).[56] They used the Luenberger productivity index which incorporates both desirable and undesirable outputs in measuring productivity based on three approaches, namely the intermediation, production and profit/revenue approaches. Credit risk is commonly identified by non-performing advances, and external factors such as economic growth, inflation and corruption are used as proxies for risk and the external environment respectively.

In addition to credit risk, which is commonly measured by indicators related to non-performing advances, Hou et al. (2014) evaluated the impact of capital risk on banking efficiency by using the ratio of equity to total assets as a proxy. The bootstrap sampling method was used in the first stage to compile DEA efficiency scores and in the second stage a truncated regression analysis was used to find the influence of risk on the technical efficiency of the Chinese banking sector for the period 2007–2011. This equity ratio has also been used as a proxy for the capital risk in many studies while some other studies have interpreted it as capital strength (Das & Ghosh 2006; Pasiouras 2008; Staikouras et al. 2008; Burgstaller & Cocca 2011; Buck & Schliephake 2013).[57] In addition, ratios of loans to deposits and of loans to total assets have been used as an indicator of liquidity in the literature (Hasan & Marton 2003; Sufian 2009a; Hou et al. 2014). These studies find that changes in liquidity have an impact on banking efficiency.

Although researchers have used their own scales or measures for categorising risk related to the banking sector, the framework established by the Basel Committee shed light on

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[56]The sample of 12 CEE countries consisted of the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Croatia, Romania, Russia, Moldova and Ukraine.

[57] Some studies have used the capital ratio (ratio of equity capital to total assets). The capital ratio is mostly in line with the equity ratio.

evaluating the impact of risk on the efficiency of the banking sector. Incorporating these risk factors into a banking efficiency analysis could be justified since the banking sector is highly integrated, particularly with the external economic environment. However, proxy variables used to quantify risk are still dependent on the methodology used by the researcher and on the availability of data. In general, the literature has highlighted the importance of the inclusion of risk into efficiency estimations in the banking sector to ensure a comprehensive efficiency analysis. Therefore, this study has included variables to capture credit risks, capital risks and liquidity risks and it evaluates their impact on banking efficiency.

3.5 Impact of the macroeconomic environment on banking efficiency and productivity

Researchers have been able to assess the impact of macroeconomic factors on efficiency using time series data for a single country and cross sectional data of panel data for groups of countries since the values of macroeconomic variables change with the time period and across countries (Dietsch & Lozano-Vivas 2000; Lozano-Vivas et al. 2001; Kasman & Yildirim 2006; Chan & Karim 2010). Initially, researchers focused on Europe in their examinations of banking efficiency and its relationship with macroeconomic factors, due to economic diversity across European countries and the availability of data (Chan & Karim 2010). Among the earliest literature on banking efficiency and the macroeconomic environment, Dietsch and Lozano-Vivas (2000) find that macroeconomic variables are important in explaining cost efficiency differences between French and Spanish banks. They used annual accounting data of commercial and savings banks in France and Spain for the period 1988–1992. Their findings reveal the impact of GDP on the efficiency of the banking sector. Their study was extended by Chaffai et al. (2001) to include two more

countries, namely Germany and Italy. Chaffai et al. confirm the finding of Dietsch and Lozano-Vivas (2000) by revealing the impact of environmental factors, including GDP, on the productivity of the banking sector. This is further confirmed by Lozano-Vivas et al. (2002) using data for 10 European countries. Their study shows a positive relationship between GDP and other environmental factors and cost efficiency.

In the context of transitional economies, Grigorian and Manole (2006) assessed the impact of macroeconomic factors on efficiency, along with some other bank-specific and business environmental variables. Their study covered the banking sector of 17 transitional economies for the period 1995–1998, and reveals a positive impact of GDP per capita in attracting deposits and generating cash flow for the banks. However, they do not identify inflation as an influential factor on banking efficiency. Similarly Fries and Taci (2005) evaluated the impact of some macroeconomic variables on the cost efficiency of 289 banks in 15 East European countries from 1994–2001, and find no influence of GDP on efficiency. Demirguc-Kunt and Huizinga (2000) also find no influence of GDP on banking sector performance for all OECD countries and a large number of developing countries for the period 1990–1997.

In contrast, a positive relationship between GDP and banking efficiency is confirmed by Kablan (2007), who find a positive influence of GDP on the cost and technical efficiency of six banks belonging to the African Economic Monetary Union (WAEMU). Chan and Karim (2010) expanded the scope of studies on the impact of macroeconomic factors on banking efficiency by focusing on a number of countries in different regions of the globe. The study estimated the cost efficiency of the banking sector for commercial banks in

Asia, the Middle East and North Africa. The results of the study show that the impact of macroeconomic factors on banking sector efficiency differs across regions. Chan and Karim (2010) find that the cost inefficiency of the banking sector in Asia had a negative correlation with real GDP per capita and private sector credit, while trade openness was positively related to banking sector inefficiency in Asia. However, they find that the cost inefficiency of the banking sector in the Middle East and North Africa is positively correlated with trade openness.

Contrary to the finding of a positive correlation between bank efficiency and macroeconomic factors, Pasiouras et al. (2009) find a negative relationship between profit efficiency and GDP growth for 615 publicly listed commercial banks in 74 countries around the globe from 2000 to 2004 using SFA. The study further reveals that the impact of GDP growth does not significantly influence cost efficiency. A correlation between efficiency and macroeconomic factors is further confirmed by Lozano-Vivas and Pasiouras (2010) using a similar methodology based on a sample of 752 publicly quoted commercial banks from 87 countries. The study also shows a negative correlation between cost efficiency and GDP growth.

The impact of macroeconomic factors on banking efficiency has been commonly evaluated in cross country studies, since most macroeconomic factors such as inflation, GDP and trade-openness are country-specific factors. In addition to macroeconomic factors, a number of other factors related to the socio-demographic conditions of each country also influence the banking industry which is linked with all sectors of the economy. The next section will explore the influence of socio-demographic factors on banking efficiency.

3.6 Impact of socio-demographic factors on banking efficiency and productivity

In addition to bank-specific, macroeconomic and business environmental factors, researchers have also employed socio-demographic factors to explain efficiency of the banking sector (see Dietsch & Lozano-Vivas 2000; Gilbert 2000; Lozano-Vivas et al. 2002; Bos & Kool 2006; Glass & McKillop 2006; Yang 2009; Battaglia et al. 2010; Jayamaha 2012). Changes in the socio-demographic environment can be observed across different geographical areas. Therefore, socio-demographic factors are mostly incorporated into efficiency studies focused on different countries and regions. Further, the socio-demographic environment can change over time, and hence socio-demographic factors have also been taken into consideration, particularly in studies using time series or panel data (Dietsch & Lozano-Vivas 2000; Glass & McKillop 2006).

Changes in banking efficiency across different geographical or political regions and the influence of socio-demographic factors such as education level, population density and unemployment level have been widely assessed in the literature. Studies on regional differences in banking efficiency in Europe were underpinned by the cross-border expansion of European banks through mergers and acquisitions (Kroszner 2008; Andries 2011). US banking sector deregulations introduced in 1996, which liberalised interstate banking, also provided motivation for evaluating banking efficiency in different geographical regions in the US.

One of the first efficiency studies concerned with country comparisons of banking efficiency was De Guevara and Maudos (2002), which analysed the cost efficiency of

banks in 14 countries belonging to the European Union using SFA. The Theil index was used to find inequalities in efficiency among the different types of banks and countries. They highlight differences in cost efficiencies between countries. Similarly, Williams and Gardener (2003) find differences in average cost efficiency of the banking sector across six countries in Europe and among regional and national banks using SFA.[58] Differences in cost efficiency in European countries is further highlighted by Fries and Taci (2005) who focus on 289 banks in 15 East European countries from 1994–2001. They find evidence for the influence of country-specific factors on cost efficiency. They computed the efficiency scores for each bank operating within 15 selected countries. The findings of Fries and Taci (2005) are further confirmed by Weill (2007) using a study based on 955 banks in 17 European countries. He argues that the gap in cost efficiency between countries could be due to environmental factors since estimations of cost frontiers including environmental factors reduced the gap.

In addition, Kasman and Yildirim (2006) investigated the cost and profit efficiency of banks in eight Central and Eastern European countries. An unbalanced panel dataset for the period 1995–2002 was used for the analysis. Differences in efficiency scores calculated for the reference period are explained by differences in the environmental factors specific to those countries. The majority of studies focused on European countries pay more attention to highlighting inequalities within the European region than measuring efficiency inequalities between countries or regions (Yildirim & Philippatos 2007; Mamatzakis et al. 2008; Kenjegalieva et al. 2009; Andries 2011).

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[58] Denmark, France, Germany, Italy, Spain and the UK

Deviating from cross-country comparisons, banking efficiency scores for regions in one country were estimated in the literature by averaging the efficiency scores of bank branches within a particular region (Miyakoshi & Tsukuda 2004; Yang 2009; Paradi et al. 2011). Researchers have analysed differences in efficiency scores in the banking sector based on these average efficiency scores. Miyakoshi and Tsukuda (2004) analysed differences in the technical efficiency of Japanese banks using data published by the Japanese Bankers Association for the fiscal year 1999, and find significant inequalities in banking efficiency between regions. Further, Jayamaha (2012) finds bank size and geographical location have an important influence on the technical efficiency of cooperative rural banks (CRBs) in Sri Lanka. He used data for 235 CRBs operating in all nine regions in Sri Lanka for the period 2005–2010. However, CRBs account for less than 1% of market share in the Sri Lankan banking sector in terms of deposits and assets.

Population density has also been identified as a potential influence on banking sector efficiency in the literature, due to the possible correlation between size of population and demand for banking services (Dietsch & Lozano-Vivas 2000; Gilbert 2000; Lozano-Vivas et al. 2002). In evaluating the possible presence of large banks in the US rural market, Gilbert (2000) concludes that the low population density in rural areas is not a barrier to large banks entering the market due to differences in the customer bases of these types of banks. Contrary to an expected decrease in cost efficiency with high population density, Dietsch and Lozano-Vivas (2000) find a negative impact of population density on the cost efficiency of the banking industry in France and Spain. Their study used DEA to estimate the cost efficiency of the banking sector in France and Spain for the period 1988–1992. The findings of Dietsch and Lozano-Vivas (2000) are further confirmed by

Bos and Kool (2006) who also used DEA to evaluate the impact of population size on cost efficiency using balanced panel data for 401 small cooperative Dutch (Rabo) banks in 1998 and 1999. A key finding of this study is that population size had a negative impact on banking sector efficiency, particularly for small banks. However Battaglia et al. (2010) confirm a significant positive impact of population density on the cost efficiency of cooperative banks in four geographical areas in Italy for the period 2000–2005. SFA was used in estimating the efficiency of the banking sector based on 2683 bank observations related to the reference period.

The impact of the education level of the population of a geographical area on banking efficiency has also been assessed in the literature. Miyakoshi and Tsukuda (2004) find a positive impact of the education level of a geographical area on the technical efficiency of the banking sector in Japan. In addition, Glass and McKillop (2006) evaluated the impact of the unemployment level of a demographic area on the efficiency of banks. Their study highlights the lower cost of the banks operating in regional areas which recorded high unemployment. The authors conclude that this might be due to the narrower product range demanded by unemployed customers.

In general literature on relationship between efficiency and socio-demographic variables are limited. Therefore, future research on efficiency should be focused on this gap in the banking efficiency literature. Hence, this study incorporates population density and education level as potential determinants of banking efficiency, particularly in regional level analysis.

3.7   The impact of banking efficiency and productivity on economic development

In reviewing the theoretical literature, economists consistently emphasise the important role of financial sector development in mobilising savings, identifying better investment opportunities by minimising information search costs, discouraging investment in unproductive assets, stimulating technological innovations, and improving risk management techniques (Schumpeter 1934; Bhattacharya & Sivasubramanian 2003; Ncube 2007; Singh 2008). In the empirical literature the relationship between financial sector development and economic growth is explained in two mainstream schools of thought.

Robinson (1953), as cited in Ang and McKibbin (2007), argues that financial development is a consequence of high economic growth. Supporters of this approach argue that the financial sector plays only a limited role in economic development, and that demand for financial services with better quality is driven by economic expansion. This approach is known as the 'demand following' hypothesis (Atindéhou et al. 2005; Levine 2005; Ang & McKibbin 2007; Demirgüç-Kunt & Levine 2008). According to the 'demand following' hypothesis the financial sector expands in an economy due to the high demand for financial services resulting from overall economic expansion. When the economy is growing, expansion in the financial sector is expected with an increase in demand for money required to maintain liquidity and high investment in the system (Quartey & Prah 2008).

The other school of thought argues that financial sector development is required for economic expansion. Patrick (1966), as cited in Kim and Lee (2007), refers to this as the

'supply leading' hypothesis. According to the supply leading hypothesis, entrepreneurial decisions to invest in more productive resources are stimulated by the availability of financial intermediation. Supporters of the supply leading hypothesis argue that financial sector expansion induces momentum in economic growth by enhancing savings and capital formation in the economy. Further to the above two main schools of thought, Greenwood and Smith (1997) and Blackburn and Hung (1998) explain financial sector development and economic growth as complements, where bi-directional causality exists between the two. In this framework, financial sector development and economic growth are not mutually exclusive, and economic expansion is reflected in the growth of monetary aggregates in the financial sector.

Although the literature in the area of financial sector development claims that an efficient and developed banking sector is an essential ingredient for economic development (Goldsmith 1969; Shaw 1973; McKinnon 1974; Bhattacharya & Sivasubramanian 2003), only a limited number of empirical studies highlight the importance of the quality of the financial sector in economic development. The impact of the quality of financial services on economic growth has also been theoretically derived by Pagano (1993), and recent empirical literature provides evidence to support this using efficiency as a proxy for financial system quality (Lucchetti et al. 2001; Koetter & Wedow 2010).

Lucchetti et al. (2001) question the suitability of indicators measuring the volume of financial flows in evaluating the causality between economic growth and financial sector development. They argue that expansion in the banking system and the amount of credit disbursed are interrelated. Although bank credit can be considered as a leading indicator of future growth, statistical analyses might show the existence of reverse causation from

economic growth to financial sector development. Therefore Lucchetti et al. (2001) incorporated a new variable, the efficiency of the banks, to capture the quality of banking services in allocating resources. This was evaluated using data relating to economic growth and banking sector performance of regions in Italy. SFA and a dynamic panel technique were employed to derive the efficiency estimates and other coefficients of the model. The findings support the existence of a positive influence of efficiency on economic growth.

More recently Koetter and Wedow (2010) identified two different channels which can capture the quantity and quality of financial sector development. First, the traditional channel of financial volumes is mainly measured by conventional monetary volumes such as M1 or M2. The second channel is the quality of the financial sector as measured by efficiency in intermediation services or operations. Koetter and Wedow (2010) conclude that there is a higher positive impact on economic growth due to the quality of the financial sector rather than the quantity, particularly in mature economies. Their study derived these conclusions from an analysis of financial development and regional growth in Germany for the period 1995–2005. Banking sector and real sector data for the 97 economic planning regions in Germany were used for the analysis.

Recent literature on the growth-finance nexus highlights the importance of the efficiency of the banking sector in stimulating the economy (Pagano 1993; Lucchetti et al. 2001; Koetter & Wedow 2010). According to this recent literature, economic growth through improvement in financial volumes might not work for economies with mature financial

sectors. Therefore, economic expansion could be expected through improving efficiency and productivity, even for a mature financial sector, particularly in developed countries.

This literature review has highlighted the influence of a large number of factors on banking sector performance. However, the selection of which factors to include in an analysis of efficiency and productivity is dependent on many considerations such as the objective of the study, context, data availability and the methodology. Accordingly, the potential factors to be included in a national level and regional level analysis in the context of this study are presented in Table 3.1. The justifications for the inclusion of some of these factors into the national and regional level analyses in this study are provided in Chapter 5 and Chapter 6.

3.8   Summary

This chapter has explored the empirical literature on banking efficiency and productivity. It has also highlighted the internal and external factors influencing the efficiency and productivity of banking institutions. This review of the literature on banking efficiency also covered four categories of influencing factors, namely bank- specific factors, business environmental factors, macroeconomic factors and

Table 3.1: Factors incorporated in national and regional level analyses.

Category	Factor included in analyses		Description of the proxy variable
	National Level	**Regional Level**	
Bank-specific factors	Branch expansion		Growth in number of bank branches
	Geographical dispersion		Percentage of bank branches outside western region
	Ownership		Domestic or foreign ownership
	Size of the business		Total assets owned by the bank
Business environment factors	NPA		Non-performing advances as a percentage of total advances
	Capital strength		Equity as a percentage of total assets
	Liquidity risk		Advances as a percentage of total assets.
	Profitability		Profitability of the bank measured by return on assets
	Reforms		Comparison of banks' performances before and after the end of the conflict
Macroeconomic factors	GDP growth		Expansion in economy
		Regional GDP per capita	Size of the regional economy measured by regional level GDP per capita
		Unemployment rate	Total unemployment as a percentage of labour force of the region
Socio-Demographic factors		Population density	Average population living in one square kilometre
		Deposit density	Average size of the bank deposit for one square kilometre
		Education level	Percentage of the people with post-secondary education level within the region

socio-demographic factors (a summary and description of the key literature reviewed is contained in Table B.1 in Appendix B). Bank-specific factors are mostly related to the internal environment of the bank while the influence of other factors comes through the external environment. Although the literature on banking efficiency is divided into four categories based on influencing factors on efficiency and productivity of the banks, the categories are not mutually exclusive since banking institutions interact with all sectors of the economy.

Among the literature focused on evaluating the impact of bank-specific factors on banking sector efficiency, more attention has been paid to ownership type, mergers and acquisitions, management quality and size of the banks by researchers. Only a small number of studies examine the impact of the outreach of the banks or expansion of branch networks on their efficiency or productivity (Deng & Elyasiani 2008; Felici & Pagnini 2008; Pasiouras et al. 2009; Mahathanaseth & Tauer 2014). Researchers focus mostly on measuring the impact of liberalisation and deregulation on efficiency and productivity, rather than measuring the impact of branch expansion subsequent to liberalisation. Therefore, it would be interesting to evaluate the impact on banking institution efficiency when banks approach new geographical areas through the expansion of branch networks while considering acquisition, merger or liberalisation policies. This study addresses this gap in the literature by investigating efficiency changes in the Sri Lankan banking sector at the national level and regional level arising from expansion in bank branch networks, particularly after the end of the armed conflict in 2009. The Sri Lankan banking sector provides a very good laboratory for investigating the impact of branch network expansion on bank efficiency in a developing country. Unlike the situations examined in cross-

country studies and single country studies in the literature, a similar regulatory environment prevails in all regions and this improves the generalisability of the results.

The relevant literature which explains the impact of business environmental factors on bank efficiency has also been reviewed in this chapter. Among the business environmental factors highlighted in the literature the impact of deregulation, competition and risk on banking efficiency have been most frequently evaluated. Banking risk is identified as a very important factor, particularly with the recurrence of banking crises, and the literature has attempted to quantify the impact of banking risk on efficiency. In addition, the Basel Committee has also very clearly defined banking risk channels and established Basel I, Basel II and Basel III frameworks to mitigate this risk. However, the literature on banking efficiency and risk has not focused enough attention on the framework established by the Basel accords by incorporating risk into their efficiency models. Therefore, this study extends the existing literature on banking efficiency and risk by introducing a comprehensive framework to quantify risk for efficiency modelling in the banking sector. The study incorporates proxies covering credit risk, capital risk and liquidity risk to evaluate their impact on banking sector efficiency. Sri Lanka provides a very good case study for evaluating the impact of risk on banking efficiency, as the central bank of Sri Lanka adapted the Basel I framework in 2008 and Basel II framework in 2013.

It is evident from the literature that the impact of macroeconomic and socio-demographic factors on banking efficiency has mostly been evaluated by means of cross-country studies, while a limited number of single country studies have also assessed the relationship between banking efficiency and these factors. The credibility of the results

of the single-country studies is questioned in the literature, since significant changes in macroeconomic and socio-demographic variables could only be observed in limited time periods for one country. Unlike in cross-country studies and single country studies in the literature, a similar regulatory environment prevailing in all regions would improve the generalisability of the results. It is evident from the literature that there is a void in credible research which evaluates the impact of macroeconomic and socio-demographic factors on banking efficiency and productivity at the regional level. Hence, this study fills a gap in the literature by evaluating the impact of macroeconomic and socio-demographic factors on banking efficiency and productivity with the objective of providing a more representative and credible picture of bank efficiency changes and differences between regions.

This chapter has explored previous studies on banking efficiency and productivity. It has grouped them into different branches of the literature and it has highlighted the knowledge gaps. The latest techniques for evaluating banking sector performance are required to address these gaps in the literature. Therefore, theoretical and methodological developments in measuring efficiency and productivity are presented in the next chapter, with particular reference to the banking sector.

Chapter 4   Methodological framework

4.1   Introduction

Chapter 3 reviewed the literature on efficiency and productivity analysis with a focus on the banking sector. In general, it was concluded that both parametric and non-parametric methods and various indices have been widely used in the literature to evaluate banking efficiency and productivity. This chapter presents methodologies which are employed in this thesis for analysing banking performance in Sri Lanka.

The methodological framework used in this study is summarised in Figure 4.1. Overall, this study employs DEA to calculate the efficiency and productivity of the banking sector. DEA is a commonly accepted and widely used technique in the literature (Berger & Humphrey 1997; Emrouznejad et al. 2008; Fethi & Pasiouras 2010). Deviating from the conventional way of comparing the performances of groups using average efficiencies, the weighted aggregate efficiency technique, introduced by Färe and Zelenyuk (2003) and Simar and Zelenyuk (2007), is also employed for comparing banking sector efficiency across different time periods, bank groups and regions. The weighted aggregate efficiencies are calculated based on the proportional contribution of each bank to total output. This technique provides a framework that assumes heterogeneity in regulatory conditions and business environment between periods, groups or regions while allowing for homogeneity within them. Apart from aggregate efficiencies, a meta-frontier technique, established by O'Donnell et al. (2008), is also used to compare the technologies across the different time periods and bank groups. The Simar and Wilson double-bootstrap truncated regression analysis approach has been employed for determining the impact of environmental variables at both the national and regional

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levels. This method is among the latest regression techniques used in efficiency studies to avoid bias which can be present in conventional OLS and Tobit models (Zelenyuk & Zheka 2006; Simar & Wilson 2007). The Global Malmquist Productivity Index (GMPI) is also employed in this study to evaluate banking sector productivity changes over time at the national level. It avoids the infeasibility issues of the conventional MPI.

Non-parametric frontier methods have been criticised in more recent literature, highlighting the bias in DEA estimates due to the non-measurement of random errors and the existence of sampling errors (Simar & Wilson 1998; 2000; Keramidou & Mimis 2011). Therefore, a bootstrapping simulation method has been used in compiling efficiency scores to avoid possible bias in such estimates caused by non-measurement of random errors and the existence of sampling errors.[59] Two thousand replications have been used to derive the bootstrap efficiency estimates and regression coefficients.

The remainder of this chapter proceeds as follows. Section 4.2 discusses the use of parametric and non-parametric frontier methods in evaluating banking sector efficiency and highlights that DEA is a widely used and commonly accepted method for analysing efficiency and productivity changes in the financial sector. The theory behind the estimation of a production frontier based on DEA is presented in Section 4.3. A comparison of banking performances between groups based on the concept of aggregate efficiency is also discussed in Section 4.3. The theoretical background of the meta-

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[59] Bootstrap techniques employ a large number of pseudo samples drawn from the given data to estimate the efficiency scores and confidence intervals of the same. A large number of pseudo samples is used in bootstrapping techniques to form an approximation for the true distribution asymptotically. Simar and Wilson (1998) and Simar and Wilson (2007) provide bootstrap algorithms to calculate bias-corrected DEA estimates.

frontier analysis is presented in Section 4.4 along with a discussion of the importance of meta-frontier analysis for comparing performance between different groups. The methodology used to find the determinants of banking efficiency is explained in Section 4.5. Section 4.6 provides the theoretical and conceptual framework of the MPI and GMPI which are used for measuring productivity changes in the sector. Details on the data and the software programs used for the empirical analysis are provided in Section 4.7 followed by Section 4.8 which provides a summary of this chapter.

Figure 4.1: Methodological framework of banking efficiency and productivity analysis at the national and regional levels
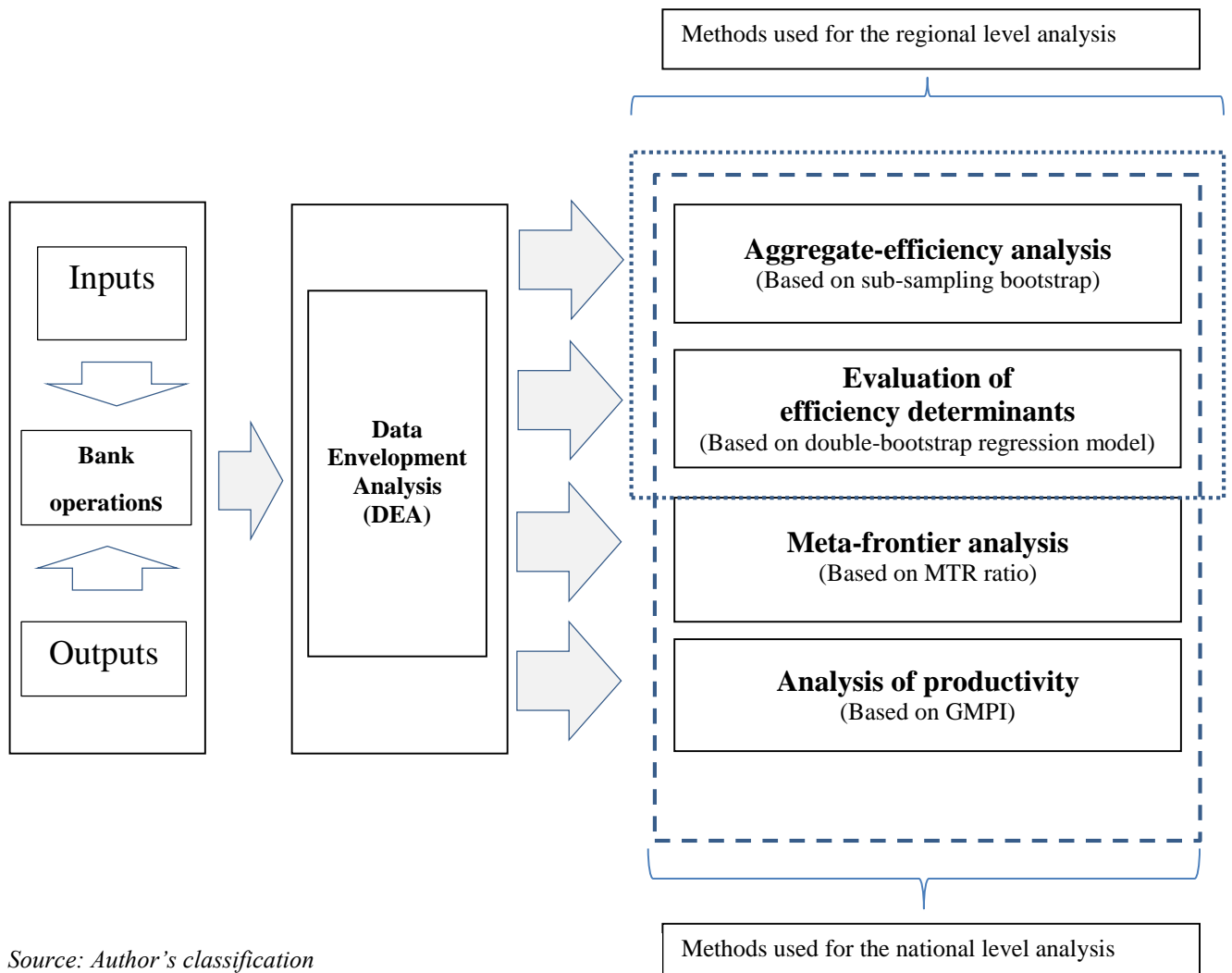
Source: Author's classification

4.2 Frontier methods of estimating efficiency

The use of both parametric and non-parametric methods in estimating the efficiency of a firm or a DMU has been extensively discussed in the efficiency literature (Farrell 1957; Seiford & Thrall 1990; Coelli et al. 2005; Fried et al. 2008; Arjomandi & Seufert 2014; Arjomandi et al. 2015; Salim et al. 2016a). Parametric methods use pre-specified functional forms such as Cobb-Douglas or Translog production functions to estimate the production frontier. Production frontiers estimated by parametric methods measure efficiency through a residual analysis. The functional form imposed on the data sample is supposed to be close to the actual production process for accurate results.

The three parametric frontier methods widely used in efficiency analysis are the stochastic frontier approach (SFA), the thick frontier approach (TFA) and the distribution free approach (DFA). SFA imposes a functional form for cost, profit and the relationships between input, output and environmental variables in the production process. A random error is allowed in SFA. Ferrier and Lovell (1990) and Berger and De Young (1997) are the pioneer studies in banking efficiency using SFA. DFA also specifies a functional form for the production process but does not impose specific distributional assumptions on random errors or inefficiencies as for the case of SFA. DFA assumes no change in inefficiency over time, and random errors average out to zero. Berger (1993), Lang and Welzel (1998) and Berger and Mester (1997) used DFA in their studies focusing on banking efficiency. With TFA, random errors are estimated based on deviations of predicted performance between the highest and lowest quintiles of observation. TFA only provides the level of overall efficiency for all DMUs and not each individual one.

The parametric methods are prone to errors due to the possibility of misspecification of the functional form (Matoušek & Taci 2004). In general, the production processes of the services sector, particularly banking services, are more complex than those of the production sector, and it is challenging to accurately specify the functional form. Further, parametric methods need a relatively large sample to estimate a substantial number of parameters (Sathye 2001). These issues can be avoided using non-parametric approaches (Kalirajan & Shand 1994). Based on these methods, a production frontier can be estimated, and then efficiency scores will be calculated relative to this frontier. Basically, all the deviations from the non-parametric frontier are treated as inefficiencies, and hence there are no random errors. The two non-parametric methods widely used in compiling efficiency estimates are DEA and Free Disposal Hull (FDH). FDH is in fact a special case of DEA: with FDH, points on the line connecting DEA vertices are not included in the frontier. Apart from the abovementioned issues, the literature highlights another advantage of using DEA for efficiency analysis in a wide range of areas which is its focus on computational optimisation rather than economic optimisation of the production process (Burki & Niazi 2010; Paradi & Zhu 2013; Liu et al. 2013b).

DEA was first introduced and formalized in linear programming by Seitz (1971) for multi-inputs and single output cases. Later, Charnes *et al.* (1978) proposed a multi-inputs and multi-outputs DEA model based on the assumption of constant returns to scale (CRS) implying that firms are operating at optimal scale. However, firms are not operating at an optimum scale some of the time due to imperfect competition, regulations and other limitations. Therefore, DEA under the VRS assumption was introduced by Färe *et al.* (1983) and Banker *et al.* (1984) to address this issue.

Since the early 1990s the usage of DEA in banking efficiency analysis has continued to increase with the development in banking sectors throughout the world. In fact, Liu et al. (2013b) showed that the highest applications of DEA techniques are reported in the field of banking, based on all research papers published in journals indexed by the Web of Science database from 1978 to 2010. This study also employs DEA with the bootstrapping simulation technique to calculate the efficiency at the national and regional levels of commercial and specialised banks in Sri Lanka.

4.3 Data Envelopment Analysis (DEA)

In the literature, models developed by economists to access the efficiency of a production process in the real world are based on a number of assumptions. They use a set of mathematical formulations incorporating such assumptions to mimic the technology set using data gathered from production processes in the real world. Generally, it is assumed that all firms have access to the same technology, T, which satisfies the regulatory axioms.[60] Another key assumption is the feasibility of the observed input-output bundle, $\left(x^k, y^k\right)$ $k = 1,..n,$ under technology set T, $(x^k, y^k) \in T$, and an alternative characterisation of technology based on an output set can be stated as $y^k \in P(x^k)$. These key assumptions can be presented in the following form:

$$Prob\{(x^k, y^k) \in T\} = 1 \qquad k = 1, ..., n$$

If the production process exhibits CRS, radial expansion or contraction of the production

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[60] See Färe et al. (1994a), Färe and Primont (1995) and Sickles and Zelenyuk (2015) for axioms of technology characterisation.

set is proportional to the non-negative scalar Z^k and is within the technology set T when $k = 1,..., n$. i.e.

$$(x^k, y^k) \in T \quad \Rightarrow \quad z^k(x^k, y^k) \in T \qquad z^k \geq 0, \qquad k = 1,...,n. \tag{4.1}$$

Assuming the additivity property of the technology, the sum of the two activities is feasible when they are feasible separately:[61]

$$\text{if } (x^k, y^k) \in T \text{ then } (\sum_{k=1}^{n} x^k, \sum_{k=1}^{n} y^k) \in T. \tag{4.2}$$

The following condition is satisfied when the CRS and additivity assumptions are considered together:

$$(\sum_{k=1}^{n} z^k x^k, \sum_{k=1}^{n} z^k y^k) \in T, \qquad z^k \geq 0. \tag{4.3}$$

According to the axiom of "free disposability" of all inputs, characterisation of technology based on input requirement set $L(y)$ satisfies the following condition:[62]

$$\sum_{k=1}^{n} z^k x^k \in L(y) \quad \Rightarrow x \in L(y) \text{ when } x \geqq \sum_{k=1}^{n} z^k x^k. \tag{4.4}$$

Similarly, the following conditions could be satisfied by the axiom of "free disposability" of outputs, that is: [63]

$$\sum_{k=1}^{n} z^k y^k \in P(x) \quad \Rightarrow y \in P(x) \text{ when } y \leq \sum_{k=1}^{n} z^k y^k. \tag{4.5}$$

An estimate for the smallest convex free disposable form of technology $(\hat{T})$ set which

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[61] The additivity property of technology is based on the assumption that the sum of two activities is feasible when those activities are feasible individually. Accordingly, $(x^i, y^i) \in T$ and $(x^j, y^j) \in T$ then $(x^i + x^i, y^j + y^j) \in T$ when $k = 1,...,n$.

[62] The axiom of free (or strong) disposability of inputs assumes that if the given technology can produce output vector using x^p input vector, then the particular technology will be able to produce y using any combination of inputs which is not smaller than the input vector x^p. This axiom is defined as follows:
$x^p \in L(y) \Rightarrow x \in L(y) \quad \forall x \leq x^p, y \in \Re_+^N$
When $x^p = \sum_{k=1}^{n} z^k x^k \Rightarrow \sum_{k=1}^{n} z^k x^k \in L(y)$.

[63] The axiom of free (or strong) disposability of outputs assumes that if the given technology can produce y^p output vector using x input vector, then the particular technology will be able to produce any combination of output which is not larger than vector y^p using the same input vector x. This axiom is defined as follows:
$y^p \in P(x) \Rightarrow y \in P(x) \quad \forall y \leq y^p, x \in \Re_+^N$
When $y^p = \sum_{k=1}^{n} z^k y^k \Rightarrow \sum_{k=1}^{n} z^k y^k \in P(x)$.

satisfies the conditions in 4.1, 4.4 and 4.5 under CRS, additivity and free disposability of inputs and outputs assumptions is defined as:

$$\hat{T} \equiv \{(x,y): y \leqq \sum_{k=1}^{n} z^k y^k, x \geqq \sum_{k=1}^{n} z^k x^k, \qquad z^k \geq 0, \quad k =,..,n. \qquad (4.6)$$

This is called the DEA estimator of production technology and it is used to formulate the following envelopment forms to measure the output-oriented technical efficiency (θ) of the observation j collected from the firm k ($j=1,...,n$ and $k=1,...,n$).

These efficiency scores are commonly referred to as DEA Farrell-output-oriented technical efficiency scores, since Farrell (1957) was the first to compile modern firm efficiency measures using multiple inputs while incorporating the seminal work of Debreu (1951) and Koopmans (1951):

$$\widehat{TE}\left(x^j, y^j\right) \equiv \max_{\theta, z_{1,...,z_n}} \theta \qquad\qquad (4.7)$$

Subject to

$$\sum_{k=1}^{n} z^k y_m^k \geqq \theta y_m^j, \qquad\qquad m = 1,...,M,$$

$$\sum_{k=1}^{n} z^k x_i^k \leqq x_i^j, \qquad\qquad i = 1,...,N,$$

$$\theta \geq 0, \qquad z^k \geq 0, \qquad\qquad k = 1,...,n.$$

These sets of linear constraints can be solved by using a linear programming technique to estimate the best production frontier and the technical efficiency (θ) of each observation. Similarly, DEA Farrell input-oriented technical efficiency scores can be obtained by

solving a set of equations with different constraints.[64]

4.3.1 Nature of returns to scale

The CRS assumption discussed above is not always valid for an empirical analysis of the production process, although it is commonly accepted in theoretical platforms. Therefore, economists are concerned about returns to scale assumptions when they estimate the best production frontier and efficiency scores. Modification of the underlying assumption on CRS is required for a production process which exhibits non-increasing returns to scale (NIRS) and VRS (Banker et al. 1994; Coelli et al. 2005; Sickles & Zelenyuk 2015).

According to non-increasing returns to scale (NIRS), any radial contraction of any observation based on scalar z^k remains in the technology set ($\hat{T}$) when

$1 \geq z^k \geq 0$ and $k = 1, \dots, n.$

This is stated in Sickles and Zelenyuk (2015) as:

$$(x^k, y^k) \in T \quad \Rightarrow \quad z^k(x^k, y^k) \in T \quad 1 \geq z^k \geq 0, \quad k = 1, \dots, n. \qquad (4.8)$$

Modification of the additivity assumption to maintain consistency of the NIRS after imposing the above condition is formally stated as:

If $(x^k, y^k) \in T,$ $\quad$ $k = 1,\dots,$ n. then $\left(\sum_{k=1}^{n} z^k x^k, \sum_{k=1}^{n} z^k y^k\right) \in T.$[65] $\qquad (4.9)$

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[64] The following set of constrains operate under CRS assumptions, additivity and free disposability of inputs and outputs:

$\widehat{TE}(y^j, x^j) \equiv \min\limits_{\theta, z_{1,\dots,z_n}} \theta$

Subject to

$\sum_{k=1}^{n} z^k y_m^k \geqq y_m^j,$ $\quad m = 1, \dots, M,$ $\qquad \sum_{k=1}^{n} z^k x_i^k \leqq \theta x_i^j,$ $\quad i = 1, \dots, N,$ $\qquad \theta \geq 0, \; z^k \geq 0, \qquad k = 1, \dots, n.$

[65] The sub-additivity property of technology is based on the assumption that the sum of two observations after radial contraction is feasible when those activities are feasible individually. Accordingly, $(x^i, y^i) \in T$ and $(x^j, y^j) \in T$ then $\left(z^k x^k + z^j x^j, z^k y^k + z^j y^j\right) \in T$ when $0 \leq z^k + z^j \leq 1, \quad z^k, z^j \geq 0, \quad$ k = $1,\dots,n.$

$$\sum_{k=1}^{n} z^k \leqq 1, \quad z^k \geq 0, \qquad\qquad k = 1, \dots, n$$

After imposing the free disposability assumption stated in the previous section, the smallest convex free disposable cone based on observed data (DEA estimates of production technology) is defined as:

$$\hat{T} \equiv \{(x, y) : \ y \leqq \sum_{k=1}^{n} z^k y^k, \qquad x \geqq \sum_{k=1}^{n} z^k x^k,$$

$$\sum_{k=1}^{n} z^k \leq 1, \quad z^k \geq 1, \quad k = 1, \dots, n. \tag{4.10}$$

Therefore, Farrell's output-oriented technical efficiency scores can be obtained by solving the following set of constrains under the assumptions of CRS, sub-additivity and free disposability of inputs and outputs assumption:

$$\widehat{TE}\left(x^j, y^j\right) \equiv \max_{\theta, z_1, \dots, z_n} \theta \tag{4.11}$$

Subject to

$$\sum_{k=1}^{n} z^k y_m^k \geqq \theta y_m^j, \qquad\qquad m = 1, \dots, M,$$

$$\sum_{k=1}^{n} z^k x_i^k \leqq x_i^j, \qquad\qquad i = 1, \dots, N,$$

$$\sum_{k=1}^{n} z^k \leq 1,$$

$$\theta \geq 0, \qquad z^k \geq 0, \qquad\qquad k = 1, \dots, n.$$

Economists have argued about the existence of technology which allows increasing returns to scale at least with low scale of production volumes (Cooper et al. 1996; Sickles

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A comprehensive geometric explanation of the sub-additivity property of the technology set is given in Sickles and Zelenyuk (2015).

& Zelenyuk 2015). However, CRS or NIRS frameworks do not allow measurement of the efficiency of firms when the technology follows increasing returns to scale. Therefore, the assumption of *convexity* should be incorporated to measure efficiency. When the assumption of convexity is made VRS is satisfied by the technology, and the following argument can be proven:

If $(x^k, y^k) \in T,$ $k = 1 \dots$ n, then $(\sum_{k=1}^{n} z^k x^k, \sum_{k=1}^{n} z^k y^k) \in T.$ [66] $\qquad$ (4.12)

$\sum_{k=1}^{n} z^k = 1, \quad z^k \geq 0, \qquad k = 1, \dots, n.$

When the free disposability of inputs and outputs assumptions are imposed on the technology, the smallest convex free disposable hull based on observed data (DEA estimates of production technology) is defined as:

$$\hat{T} \equiv \{(x, y) \; : y \leqq \sum_{k=1}^{n} z^k y^k,$$

$x \geqq \sum_{k=1}^{n} z^k x^k, \sum_{k=1}^{n} z^k = 1, \quad z^k \geq 1, \; k = 1, \dots, n. \qquad (4.13)$

$$\text{when } \{(x^k, y^k) : k = 1, \dots, n\}$$

This estimate of production technology can be used to obtain Farrell's DEA output-oriented technical efficiency scores by solving the following set of constraints under the VRS assumption and the free disposability of inputs and outputs assumption:

$$\widehat{TE}\left(x^j, y^j\right) \equiv \max_{\theta, z_1, \dots, z_n} \theta \qquad (4.14)$$

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[66] The assumption of convexity is defined as $(x^i, y^i) \in T$ and $(x^j, y^j) \in T$ then $\left(z^k x^k + z^j x^j, z^k y^k + z^j y^j\right) \in T$ when $z^k + z^j = 1, \; z^k, z^j \geq 0,$ k $= 1, \dots, n.$ A comprehensive geometric explanation of the *convexity* assumption of the technology set is given in Sickles and Zelenyuk (2015).

s.t.

$$\sum_{k=1}^{n} z^k y_m^k \geqq \theta y_m^j, \qquad\qquad m = 1, \dots, M,$$

$$\sum_{k=1}^{n} z^k x_i^k \leqq x_i^j, \qquad\qquad i = 1, \dots, N,$$

$$\sum_{k=1}^{n} z^k = 1,$$

$$\theta \geq 0, \qquad z^k \geq 0, \qquad\qquad k = 1, \dots, n.$$

Similarly, DEA Farrell input-oriented technical efficiency scores can also be obtained.[67]

The assumption of VRS has been used in the literature in calculating firms' efficiency as CRS is not suitable when the firms are not operating at optimal scale. This is especially the case for financial sector institutions such as banks (Bossone & Lee 2004; Mester 2005). Therefore, VRS has been used in this study. Further, the output-orientation approach has also been used in this study for compilation of efficiency scores. The use of an input or output orientation is dependent on the objective of the analysis (Coelli et al. 2005). In the post-conflict era in Sri Lanka, policy makers and bankers pursued output maximisation rather than input minimisation with expansion in the banking sector along with the growth momentum in the economy. Therefore, an output-orientation approach is more appropriate for analysis targeting policy formulation in the banking industry of Sri

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[67] The DEA Farrell input-oriented technical efficiency scores could be obtained by solving the following set of constraints under the assumption of VRS:

$$\widehat{TE}\left(y^j, x^j\right) \equiv \min_{\theta, z_{1,\dots,z_n}} \theta$$

subject to

$$\sum_{k=1}^{n} z^k y_m^k \geqq y_m^j, \quad m = 1, \dots, M, \quad \sum_{k=1}^{n} z^k x_i^k \leqq \theta x_i^j, \quad i = 1, \dots, N, \quad \sum_{k=1}^{n} z^k = 1,$$

$$\theta \geq 0, \qquad z^k \geq 0, \qquad\qquad k = 1, \dots, n.$$

Lanka.

4.3.2 Estimation of an efficient frontier based on bootstrap simulations

Since DEA assumes the non-existence of random errors, the calculated efficiencies can be downward biased. Therefore, DEA could rate banks as more efficient than they truly are. Although the bias could be avoided asymptotically with large samples, efficiency studies in banking mostly do not deal with large samples (Sherman & Gold 1985; Grabowski et al. 1993; Casu & Molyneux 2003; Kenjegalieva et al. 2009; Burki & Niazi 2010).[68] Therefore, the bootstrap simulation procedure used by Simar (1992) and Simar and Wilson (1998; 2000) has been employed to correct the bias of non-weighted efficiency scores which is an extension of the bootstrapping technique originally established by Efron (1979).

In bootstrap techniques, a large number of pseudo samples drawn from given data enable the estimation of biased corrected efficiency scores and confidence intervals for each firm. Simar and Wilson (1998) show that the consistency of estimates derived from the bootstrap technique is dependent on the replication of the data generating process. Simar and Wilson (2000) introduced more smooth estimates to minimise the inconsistency of the bootstrap samples due to the re-sampling related to the original sample. The detailed steps in generating bootstrap confidence intervals of the efficiency scores are provided by Simar and Wilson (2000).

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[68]The consistency of DEA estimates improves with increased sample size for given input and output dimensions (Banker 1993).

4.3.3 Aggregate efficiency

This section discusses the theoretical background of the efficiency measurements and the contemporary methodologies used in the recent literature to compile efficiency scores and compare the efficiency of different groups of firms. Simple arithmetic averages have mostly been used for comparing the efficiencies of groups of firms in different periods. This is due to the lack of a reliable point estimator (Simar & Zelenyuk 2007; Thilakaweera et al. 2015; Thilakaweera et al. 2016a). Färe and Zelenyuk (2003) and Simar and Zelenyuk (2007) addressed this gap in the theoretical literature by developing a point estimator for the aggregate efficiency of a group of firms. This section explains technical efficiency between groups based on aggregate efficiency measures developed by Färe and Zelenyuk (2003), Färe and Zelenyuk (2007) and Simar and Zelenyuk (2007). In the banking industry, such groupings are mostly based on factors such as ownership structure, size of the banks and regulatory regimes.

The methodology for comparing groups using aggregate efficiency can be explained in the context of the banking industry by considering a sample of n banks. For bank k $(k = 1,...,n)$ an inputs vector comprising N inputs, $x^k = (x_1^k,...,x_N^k)' \in \Re_+^N$, is used for the production of M outputs, $y^k = (y_1^k,...,y_M^k)' \in \Re_+^M$. Each bank is free to use technology that can be characterised by the technology set T^k:

$$T^k = \left\{ \left(x^k, y^k \right) : x^k \, can \, produce \, y^k \right\} \tag{4.15}$$

Equivalently, the technology can be characterised by the following output set P^k:

$$P^k(x^k) \equiv \{ y^k : x^k \, can \, produce \, y^k \}, \; x^k \in \Re_+^N \tag{4.16}$$

Assuming the regularity axiom of production theory, the Shepherd (1970) distance function with respect to the output-orientation can be defined as:

$$D_0^k(x^k, y^k) \equiv inf\left\{\theta : y^k / \theta \in p^k(x^k)\right\} \text{ where } D_o^k : \Re_+^N \times \Re_+^M \to \Re_+^1 \cup \{\infty\} \qquad (4.17)$$

The complete characterisation of the technology of bank k proves that:

$$D_0^k(x^k, y^k) \leq 1 \leftrightarrow y^k \in p^k(x^k). \qquad (4.18)$$

Accordingly, Farrell's output-oriented technical efficiency can be defined for all outputs y^k as:

$$TE^k(x^k, y^k) \equiv max\left\{\theta : \theta y^k \in p^k(x^k)\right\} = 1 / D_0^k(x^k, y^k). \qquad (4.19)$$

When the bank is "fully" efficient, $TE^k = 1$. If $TE^k > 1$, the bank is considered to be technically inefficient.

Since output sets are unknown due to the unobserved true technology, DEA is employed to estimate the technical efficiency of individual banks. The DEA estimate of the output set $p^k(x^k)$ is defined as:

$$\hat{p}^k(x^k) \equiv \left\{y : \sum_{k=1}^n z^k y^k \leq y, \sum_{k=1}^n z^k x^k \geq x, \sum_{k=1}^n z^k = 1, z^k \geq 1, k = 1,...,n\right\} \qquad (4.20)$$

where z^k is an intensity variable.

The output set is estimated based on VRS assuming that banks are not operating at optimal scale due to the exogenous and endogenous factors mentioned above. Accordingly, individual bank efficiency scores based on DEA at a fixed point (x^k, y^k) can be derived by solving the following linear programming problem:

$$TE_{VRS}^k\left\{x, y : p^k(x^k)\right\} \equiv \max_{\theta, z^1, z^2 ..... z^k}\left\{y : \theta y \in p^k(x^k)\right\} \qquad (4.21)$$

Since DEA assumes the non-existence of random errors, $TE_{VRS}^k \left\{ x, y : p^k(x^k) \right\}$ is a downward biased estimator of $TE_{VRS}^k \left\{ x, y : p^k(x^k) \right\}$ for the finite sample of banks.

It should be noted that the aggregation procedure defines a common technology frontier which inherits its properties from those of the firms' technologies where each firm may have a different technology (Färe & Zelenyuk 2003). Simar and Zelenyuk (2007) defined group efficiencies based on the aggregate efficiency of all firms within each distinct group under the common technology where groups are distinguished by the heterogeneity of the operating environment in which production takes place.

Accordingly, the aggregate technical efficiency of group l ($\overline{TE}^l$) could be disaggregated into the weighted average of the technical efficiencies of all the individual banks where group l comprises n_l observations and technical efficiency of the individual bank k is $\overline{TE}^{l,k}$:

$$\overline{TE}^l \equiv \sum_{k=1}^{n_l} \overline{TE}^{l,k} . S^{l,k} \tag{4.22}$$

where $y^{l,k}$ is bank k's output, $S^{l,k}$ represents the output weight of the bank k in group l, $S^{l,k} = py^{l,k} / p\overline{Y}^l$, p is the vector of output prices, and the output vector of all firms in the lth group is $\overline{Y}^l = \sum_{k=1}^{n_l} y^k, k = 1,...,n_l$. $\tag{4.23}$

Similarly, when the sample consists of L non-overlapping groups, the sample's aggregate technical efficiency of ($\overline{\overline{TE}}$) can be disaggregated into the weighted averages of technical efficiency of all L groups as follows:

$$\overline{\overline{TE}} \equiv \sum_{l=1}^{L} \overline{TE}^{l} . S^{l}$$

where $S^{l} = p\overline{Y}^{l} / p\sum_{l=1}^{L}\overline{Y}^{l}$ and $\overline{Y}^{l} = \sum_{k=1}^{n_l} y^{k}, k = 1,...,n_l$.

When the price information is not available, price independent weights can be used instead of S^{l} as detailed in Simar and Zelenyuk (2007).

Formulation of bootstrap aggregate efficiency measures

The bootstrap technique is also used in the context of aggregate efficiency to derive consistent estimates. Based on the smooth bootstrapping technique of Simar and Wilson (1998; 2000) for estimating DEA efficiency scores, Kneip et al. (2003a) introduced the bootstrap technique for sub-sampling. The main advantage of this sub-sampling method is that it accounts for heterogeneity between the sub-samples. The Monte Carlo experiments have proven the consistency of the sub-sampling bootstrap, which is faster than the smooth bootstrap. The variation in the precision of estimates with sample size is the main highlighted disadvantage in using the sub-sampling bootstrap. This matter was addressed by Kneip et al. (2003b) to some extent. Simar and Zelenyuk (2007) employed the Kneip et al. (2003b) method and introduced a point estimate for comparing aggregate efficiencies between two groups. The comparison of aggregate efficiencies between two groups is explained in the following section.

Comparison of aggregate efficiency between subgroups

It is important to statistically compare the significance of differences in efficiency between two or more groups of firms. Although the Kruskal-Wallis test has been used to compare efficiency between different groups of firms in past studies of efficiency, the

appropriateness of this test is questionable since it does not incorporate economic weights for the subgroups. Therefore, Simar and Zelenyuk (2007) presented the $RD_{A,B}$ test statistic to compare the aggregate effciency of two groups of firms. $RD_{A,B}$ is derived from the ratio of aggregate effciency of the subgroup A ($\overline{ATE^A}$) and subgroup B ($\overline{ATE^B}$). The ratio approaches unity ("1") when the aggregate efficiencies of the two sub groups are the same. If the confidence interval of $RD_{A,B}$ does not contains unity, the test concludes the existence of a significant gap in aggregate effciency between the subgroups.[69] Algorithms for computation and comparison of bootstrap aggregate efficiency are given in Appendix C.

In addition to Simar and Zelenyuk's test, based on the ratio of subgroup's aggregate effciency, Simar and Zelenyuk (2006) and Henderson and Zelenyuk (2007) used a test developed by Li (1996; 1999) for comparing the efficiencies of two groups. This test measures inequality between the densities of two variables rather than comparing the point estimates of two groups. Application of the Li test for comparing densities of efficiency scores is provided in Appendix C.

These methods are also used in this study to compare banking efficiency in the periods before and after the end of the armed conflict, to compare different groups of banks at the national level, and to compare efficiency levels across different regions in Sri Lanka. Such groupings can be seen as highly appropriate in the case of Sri Lanka due to the changes in the business environment after the end of the conflict, heterogeneity

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[69] Henderson and Zelenyuk (2007) also employed this point estimate of aggregate efficiency of groups in evaluating the convergence and divergence of economic growth in 52 countries.

between bank groups and also regional level differences. Although aggregate efficiency is used to compare the performances between bank groups, it does not provide the differences in technology sets used by them. Therefore, meta-frontier analysis explained in the next section is employed to provide comparisons between technology sets used by the bank groups.

4.4   Meta-frontier analysis

O'Donnell et al. (2008) highlight the differences in technology sets used by the groups of firms due to differences in production opportunities. They also state that:

> technology sets differ because of differences in available stocks of physical, human and financial capital (e.g., type of machinery, size and quality of the labour force, access to foreign exchange), economic infrastructure (e.g., number of ports, access to markets), resource endowments (e.g., quality of soils, climate, energy resources) and any other characteristics of the physical, social and economic environment in which production takes place (O'Donnell et al. 2008,p. 231-232).

Accordingly, they proposed meta-frontier analysis, a theoretical framework for comparison of the best technologies used by firms belonging to different groups. In meta-frontier analysis, the efficiency of a firm in each group is measured with respect to the group frontier which is constructed using the best performers within the group. However, as a general rule, comparisons across groups of firms are not possible with separate frontiers. Based on the concept of the meta-production function defined by Hayami and Ruttan (1971), a meta-frontier is established by enveloping all group frontiers, enabling

a comparison of frontiers across the groups.[70] In addition to the comparison across groups, O'Donnell et al. (2008, p. 231) specifically mentioned the validity of meta-frontier analysis for comparison of the technology sets of an industry over time.

In this study, banking sector technology sets are assessed before and after the end of the armed conflict and between different bank groups in Sri Lanka. Differences in technology sets used by the banking sector at the regional level are not evaluated since the banks selected for regional analysis operate in all nine regions. Therefore, it is assumed that there are no significant differences in technology sets used by a bank between the nine regions since the same banks are operating throughout nine regions.

4.4.1 The meta-frontier

Let each firm in the industry use x inputs to produce y outputs. The x and y are non-negative vectors of real values with dimensions ($M{\times}1$) and ($N{\times}1$), respectively. The production set of the industry for a given meta-technology set can be defined by:

$$T = \{(x,y): x \in \mathbb{R}_+; y \in \mathbb{R}_+: x \; can \; produce \; y\} \tag{4.24}$$

This production set comprises two components, namely the boundary and the interior. The efficient firms or best-practice firms construct the meta-frontier (or boundary). The meta-distance function using output orientation is defined as:

$$D(x,y) = inf_\theta\{\theta: (x, y/\theta) \in T\}. \tag{4.25}$$

Therefore, the maximum possible expansion of a firm output vector for a given input vector is provided by this function. When the $D_o^k(x^k, y^k) = 1$, an observation (x, y) can

---

[70] The meta-production function concept was introduced by Hayami and Ruttan (1971) as the envelope of commonly conceived neoclassical production functions.

be considered as a technically efficient firm with respect to the meta-frontier. A firm is relatively inefficient if it is inside the interior of the frontier (that is $(D_o^k(x^k, y^k) < 1)$).

4.4.2 Group frontiers

Different sub-technologies can exist for different groups of firms due to the resource, regulatory or other environmental constraints which prevent them from acquiring a meta-technology set. When the sample of firms is divided into K (>1) groups, the sub-technology of the kth group is T^k.

These sub-technologies can be characterised as group-specific production sets and group output distance functions:

$T^k = \{(x, y): x \in \mathbb{R}_+; y \in \mathbb{R}_+: x \; can \; be \; used \; by \; firms \; in \; group \; k \; to \; produce \; y, \}$

where $k = 1, \dots, K$ and

$$D^k(x, y) = inf_\theta \{\theta: (x, y/\theta) \in T^k\}. \tag{4.26}$$

The boundaries of these group-specific production sets are the frontiers of the k groups. All these K production sets are enveloped by the meta-production set $T \equiv T^1 \cup T^2, \dots, \cup T^K$. Hence, group-specific production sets are considered as subsets of the meta-production set.

4.4.3 Meta-technology ratios

The gap between the group k distance function and the meta-distance function provides a measure of the inequality of the technology sets between the industry frontier (best performers in all the groups) and that of group k. This gap can be defined as the meta-technology ratio (MTR) for a particular set of input and output combinations (x^k, y^k):

$$MTR^k(x, y) = \frac{D(x, y)}{D^k(x, y)} = \frac{TE(x, y)}{TE^k(x, y)} \tag{4.27}$$

where $D(x, y)$ and $D^k(x, y)$ are the distance functions with respect to the meta-frontier and group frontier, respectively. Since Farrell's output-oriented technical efficiency can be defined as $1/D$, MTR is also equal to the ratio of technical efficiency calculated based on meta-frontier and group frontier, respectively. Therefore, the average of all individual MTRs of firms within a group indicates the proximity (closer or further away) of group frontier relative to the meta-frontier.

Equation (4.27) can also be presented as:

$$TE(x, y) = TE^k(x, y) \times MTR^k(x, y) \tag{4.28}$$

According to Equation 4.28, technical efficiency measured with respect to the meta-frontier can be decomposed into technical efficiency with respect to the group frontier and the meta-technology ratio of the group k.

4.5 Analysis of determinants of banking efficiency

In the literature the impact of environmental variables on banking efficiency has mostly been gauged using regression methodologies such as OLS and Tobit (Simar & Wilson (2007). Among all the methodologies, Tobit regression models which regress efficiency scores against selected explanatory variables have been the ones most frequently used in the recent literature (Chang & Chiu 2006; Burki & Niazi 2010). The main weakness of the Tobit model, however, is violation of a basic assumption in regression analysis, since DEA efficiency scores are serially correlated with the error term. This serial correlation exists since observations lying on the efficient frontier could influence the efficiency levels of other firms (Xue & Harker 1999; Hirschberg & Lloyd 2002; Simar & Wilson

2007).[71] Simar and Wilson (2007) introduced a bootstrapped truncated regression technique to avoid violation of this basic assumption and provided more sensible results for the regression by incorporating the underlying data generating process. Their bootstrapping technique estimates the coefficients of the regression model based on a large number of independent samples drawn with replacements and it works well with the small samples that are common in banking efficiency studies. Therefore, this technique is used to estimate the coefficients and their confidence intervals in the regression model.

Simar and Wilson (2007) proposed two bootstrap procedures to find a factor's influence on the banking efficiency score which avoid the weaknesses which are present in conventional methods used in the literature. The first procedure, named "Algorithm 1", uses a single-stage bootstrap while the second procedure, named "Algorithm 2", uses a two-stage bootstrap procedure to find the determinants of efficiency. The estimates provided by single-stage bootstrap procedure are better than the conventional regression analysis since it is designed to improve on inference. But the single-stage bootstrap procedure does not take account of bias in the efficiency estimates. The two-stage procedure is designed to improve on inference and take account of the bias of estimates. Therefore the two-stage bootstrap procedure provides consistent and unbiased estimates unless the sample size is too small. In this study, the two-stage bootstrap regression procedure has been employed. For a comprehensive description of bootstrap truncated regression analysis see Simar and Wilson (2007).

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[71] Firms lying on the efficient frontier decide the others' efficiency scores.

In the two-stage regression analysis, first, efficiency scores are calculated based on DEA. Second, those efficiency scores are regressed against potential environmental variables (determinants), as identified in the following equation:

$$\hat{\theta}_{vrs_i} = a + X_i\delta + \epsilon_i \qquad i = 1,2,\dots,n \tag{4.29}$$

where a is constant, ϵ_i is the statistical error term, and X_i is the vector of potential explanatory variables or determinants of efficiency. The environmental and control variables used in national level and regional level efficiency analyses will be discussed later in Chapter 5 and Chapter 6 respectively.

4.6 Productivity indices

4.6.1 Malmquist productivity index (MPI)

The concept of this index was originally proposed by Malmquist (1953) based on a radial type measure of two quantity vectors with respect to an indifference curve. Based on this concept and incorporating Shephard's output distance function, it was then developed by Caves et al. (1982).

Shephard's distance function $D_o^l(x_l, y_\tau)$ for the input x_l observed in period l (l=s,t) and for the output y_τ observed in period $\tau(\tau = t, s)$ under technology available in period l (l=s,t) is defined as:

$$D_o^l(x_l, y_\tau) = \inf\{\theta > 0: \left(\frac{y_\tau}{\theta}\right) \in P^l(x_l)\} \tag{4.30}$$

where θ is technical efficiency and P^l is the technology available in period l (l=s,t). This distance function can be used to define the Malmquist output-quantity indices given in Equations (4.31) and (4.32) based on technology used in time period s and period t, respectively.

$$Q_o^s(y_s, y_t, x_s) \equiv \frac{D_o^s(x_s, y_t)}{D_o^s(x_s, y_t)} \qquad (4.31)$$

$$Q_o^t(y_s, y_t, x_t) \equiv \frac{D_o^s(x_t, y_t)}{D_o^s(x_t, y_s)} \qquad (4.32)$$

Figure 4.2 can be used to give a geometric explanation of the Malmquist output quantity index for the period s by measuring the distance between two output combinations y_s and y_t. The output-oriented isoquant that goes through points B and C is based on input x_s and technology in period s. Accordingly, the Malmquist output-quantity index for the period s is derived from the radial distance between points C and D after adjusting for output-oriented technical efficiency in period s incorporating the radial distance between points A and B. Similarly, the output isoquant that goes through the

Figure 4.2 : Geometric intuition of Malmquist output-quantity index
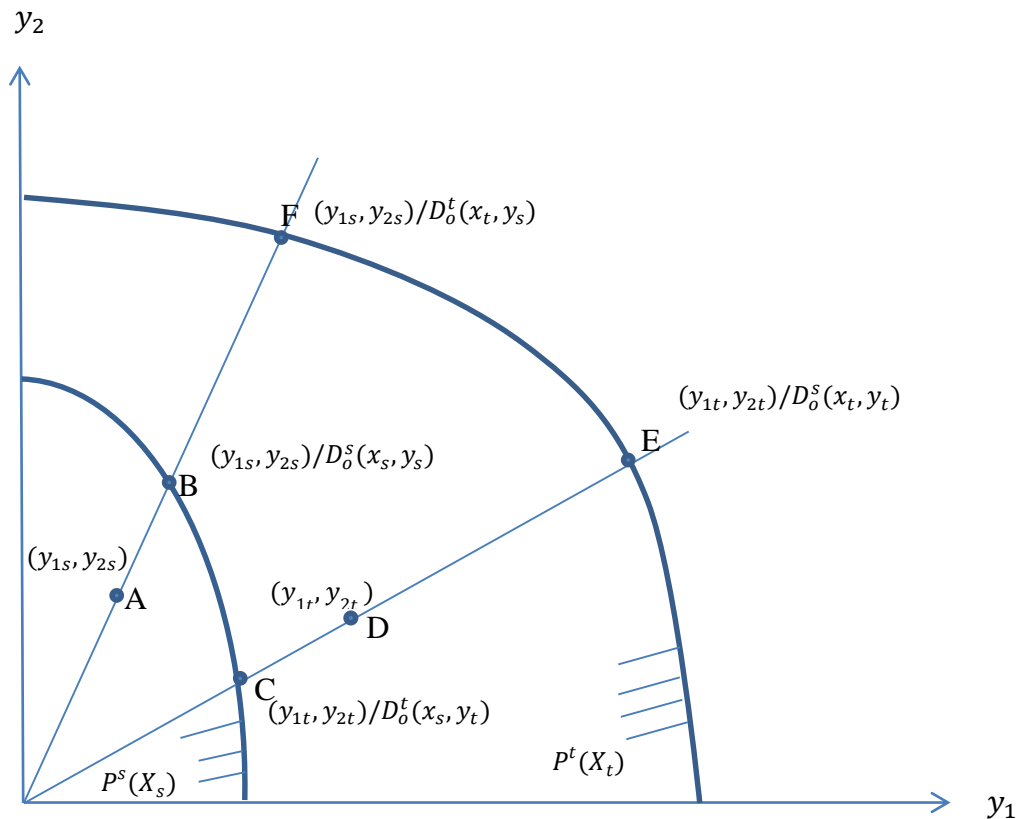
Source: Sickles and Zelenyuk (2015)

points E and F represents the input x_t and technology in period s. Hence, the Malmquist output quantity index for the period t is derived from the radial distances DE and AF. The geometric explanation of the Malmquist input quantity index can also be obtained by using an input-oriented isoquant (Sickles & Zelenyuk 2015).

Based on the Malmquist quantity index, Caves et al. (1982) also introduced the MPI to measure total factor productivity between two time periods based on the distance between two output allocations relating to a common technology observed in one period. An output-oriented MPI, when all the quantities are measured with respect to time period s, is defined as:

$$M_o^s(y_s, y_{t}, x_s, x_t) \equiv \frac{D_o^s(x_t, y_t)}{D_o^s(x_s, y_s)}.$$ (4.33)

Similarly, an output-oriented MPI when all the quantities are measured with respect to time period t is defined as:

$$M_o^t(y_s, y_{t}, x_s, x_t) \equiv \frac{D_o^t(x_t, y_t)}{D_o^t(x_s, y_s)}.$$ (4.34)

Figure 4.3 provides a geometrical explanation of the output-oriented MPI with respect to time period s, as defined in (4.33), by measuring the distance between two input-output allocations (x_s, y_s) and (x_t, y_t). First, the projection of actual input-output on the technological frontier in period s is measured using the distance between points A and B, and then the output-oriented technical efficiency change from period s to t is measured by using the distance between C and D. Similarly, the output-oriented MPI with respect to the time period t can also be defined based on the distances CE and AF. The geometric

mean of the two MPIs compiled with respect to two time periods is commonly used by researchers to avoid the arbitrariness of choice of the reference time period.

Figure 4.3: Geometric intuition of Malmquist output productivity index
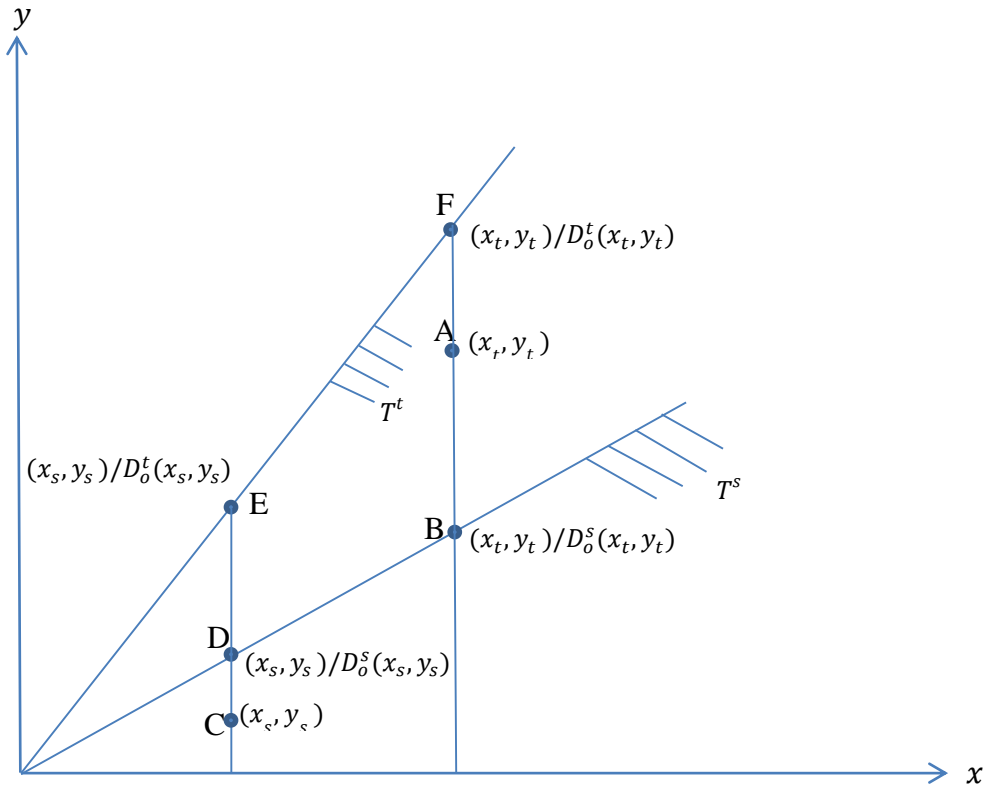
Therefore, MPI is commonly defined as:

$$M_o\left(y_s, y_t, x_s, x_t\right) \equiv \left[\frac{D_o^s(x_t, y_t)}{D_o^s(x_s, y_s)} \times \frac{D_o^t(x_t, y_t)}{D_o^t(x_s, y_s)}\right]^{1/2}. \tag{4.35}$$

An input-oriented MPI can also be defined in a similar fashion based on Shephard's distance function.

Decomposition of the MPI into different sources of productivity is presented by Färe et al. (1994b) and this decomposition has also contributed to the popularity of MPI.

Decomposition of the MPI into an efficiency change and a technology change as presented by Färe et al. (1994b) is defined as:

$$
\begin{aligned}
M_o(x_s, x_t, y_s, y_t) \quad &\equiv [(M_o^s(x_s, x_t, y_s, y_t)) \times (M_o^t(x_s, x_t, y_s, y_t))]^{1/2} \\[2mm]
&\equiv \left[\frac{D_o^s(x_t, y_t)}{D_o^s(x_s, y_s)} \times \frac{D_o^t(x_t, y_t)}{D_o^t(x_s, y_s)} \right]^{1/2} \\[4mm]
&\equiv \left[\frac{D_o^t(x_t, y_t)}{D_o^s(x_s, y_s)} \right] \times \left[\frac{D_o^s(x_s, y_s)}{D_o^t(x_s, y_s)} \times \frac{D_o^s(x_t, y_t)}{D_o^t(x_t, y_t)} \right]^{1/2} \\[4mm]
&\equiv [Change\ in\ Efficiency\ ] \times [Change\ in\ Technology] \\[2mm]
&\equiv [\Delta\ eff.] \times [\Delta\ tech.]. \qquad\qquad (4.36)
\end{aligned}
$$

The MPI defined by Caves et al. (1982) is not based on any specific returns to scale assumption regarding the production technology. None of the distances to be computed for the compilation of MPI under the input or output orientation are influenced by the returns to scale exhibited by the production technology. Later, Färe et al. (1994b) provided decomposition of the MPI based on both CRS and VRS assumptions. This decomposition was enriched further by the work of Ray and Desli (1997).

4.6.2 Global Malmquist Productivity Index (GMPI)

The above explained MPI is among the most popular indices for capturing productivity. It has a number of attractive features in measuring and disaggregating the productivity changes of firms (Färe et al. 1997; Zelenyuk 2006). In a conventional method the geometric average of the MPI is used to compare productivity across different groups of firms. However, when linear programming techniques are used for the decomposition of

the MPI, infeasibility can occur, particularly with respect to the VRS. In the context of the financial sector, institutions, particularly banks, do not operate at an optimum scale most of the time due to imperfect competition, regulations and other limitations and a VRS assumption is more suitable for analysis of their performance.

Based on the MPI, Pastor and Lovell (2005) introduced GMPI which is not prone to the infeasibility problem with VRS. GMPI is more suitable for this study for three main reasons. First, the GMPI is circular which is considered a favourable condition for the indexes of adjacent period technologies (Färe & Grosskopf 1997). Second, the GMPI provides a single measure and does not depend upon the time direction. Third, and most importantly, the GMPI measures the frontier shift with respect to the best technology of the whole study period and is not limited to adjacent periods. Using the GMPI, an investigation of banking technological change over the periods before and after armed conflict can be undertaken with respect to the best technology that prevailed in the reference period 2006–2014.

Based on the presentation of MPI in the previous sub-section, the GMPI is defined on T^G as:

$$M^G\left(y_s, y_{t,} x_s, x_t\right) \equiv \frac{D^G(x_s, y_s)}{D^G(x_t, y_t)} \tag{4.37}$$

where the output distance function of the global frontier with respect to both time period s and t is $D(x, y) = \min\{\theta > 0 : (x, y/\theta) \in T^G\}$.

The geometric mean convention is not required when defining the GMPI since there is only one benchmark technology for the period.

Therefore, M^G decomposes as:

$$M^G(y_t, x_s, x_{t,\stackrel{\leq}{>}}y_s) = \left(\frac{D^s(x_s, y_s)}{D^t(x_t, y_t)}\right) \times \left[\left(\frac{D^G(x_s, y_s)}{D^s(x_s, y_s)} \times \frac{D^t(x_t, y_t)}{D^G(x_t, y_t)}\right)^{-1}\right]$$

$$= \left(\frac{TE^s(x_s, y_s)}{TE^t(x_t, y_t)}\right) \times \left[\left(\frac{D^G(x_s, y_s)/D^s(x_s, y_s)}{D^G(x_t, y_t)/D^t(x_t, y_t)}\right)^{-1}\right]$$

$$= EC \times \left[\left(\frac{BPG^{G,s}(x_s, y_s)}{BPG^{G,t}(x_t, y_t)}\right)\right]$$

$$= EC \times \text{BPC}, \tag{4.38}$$

where EC is the efficiency change and $BPG^G \leq 1$ is the best practice gap between the meta-technology T^G and the technology of the reference period s or period t (T^t or T^s). BPC is the best-practice change in technology relative to the meta-technology. The change in BPG^G is given by BPC. Further, BPC indicates the proximity (closer or further away) of the benchmark technology of a period relative to the global benchmark technology. Therefore, BPC > 1 and BPC < 1 indicate positive and negative technological changes, respectively. In addition to the GMPI, EC and BPC are also circular as other fixed based indexes.

4.7 Data and software

The data source used for this research are annual accounts published by banks operating in Sri Lanka and a comprehensive set of regional level banking data collected by the CBSL. Panel data for the period 2006–2014 is extracted from the annual reports and published financial accounts of the banks for national level analysis. The regional level analysis is based on banks' operational and financial data with respect to each region for the period 2011−2014. Detailed descriptions are provided with respect to the above two

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data sets in Chapter 5 and Chapter 6.

The study uses the "R" statistical software package and MaxDEA software to estimate the production frontier and evaluate efficiency and productivity in the banking sector. "R" is a software package widely accepted and commonly used by economists, as can be observed from recent econometric studies (Muenchen 2012). The package is a free and open source software package which continues to be developed due to the contribution of researchers worldwide. MaxDEA is a specialised package for efficiency analysis and the latest version, MaxDEA Pro, comprises comprehensive DEA models and productivity measures. The MATLAB program used in Simar and Zelenyuk (2007) for comparing two groups was also used and extended to compare the aggregate efficiencies between three bank groups and nine regions in Sri Lanka. Further, a new MATLAB program has been developed by adopting codes used in Simar and Zelenyuk (2007) for deriving bootstrap estimates in meta-frontier analysis. The determinants of banking efficiency at the national and regional levels are evaluated by using the MATLAB programs developed by Simar and Zelenyuk to carry out double-bootstrap truncated regression analysis.

4.8   Summary

This chapter explains the methods and theoretical concepts used in the empirical analysis of this study to evaluate the efficiency and productivity of the Sri Lankan banking sector. As per the methodological framework given in Figure 4.1, DEA is used to gauge the efficiency of Sri Lankan banks in the first phase of the analysis. Therefore, the theoretical concept of the DEA is explained with respect to both VRS and CRS assumptions. In addition, the theoretical underpinning of the aggregate efficiency measure used to compare the performances of groups is also explained in this chapter. To the best of the

author's knowledge this study is: 1) the first to use aggregate efficiency to compare banks' performances across the two periods immediately before and after the end of the armed conflict in Sri Lanka, 2) the first banking efficiency study which uses aggregate efficiency to compare the regional level efficiency of the banking sector in more than two regions. The aggregate efficiency technique, which accounts for the size of each bank in efficiency measures, is new to the banking efficiency literature and it is an ideal method for comparing banking sector performance, particularly across bank groups, regions and time periods.

In addition to using the aggregate efficiency technique to compare groups, the meta-frontier techniques presented in this chapter are also employed to compare the technology sets used by the banking sector in the periods before and after end of the armed conflict in Sri Lanka. The technology sets of bank groups are also compared based on this technique. This technique is new to the literature on banking efficiency and this study is one of the few that applies the meta-frontier technique to compare banking sector performance across groups.

As depicted in Figure 4.1, two-stage bootstrap truncated regression models (so-called double-bootstrap regressions) are used in the empirical analysis in order to identify the determinants of banking sector efficiency. The determinants of banking efficiency are identified at both the national and regional levels in the empirical analysis. This study is also the first to examine the determinants of banking efficiency by using bootstrap truncated regression models for the Sri Lankan banking sector. In addition to the efficiency measures based on DEA, this chapter explores the theoretical and conceptual

frameworks of the GMPI and MPI which are used to evaluate the changes in productivity of the banks during the period 2006–2014.

Overall, this chapter has provided the methodologies used in the empirical analysis of this study along with their theoretical background. The empirical results derived by employing the methodologies provided in this chapter are presented in Chapter 5 and Chapter 6.

Chapter 5   Banking sector efficiency in Sri Lanka and its determinants

5.1   Introduction

An empirical application of the proposed framework for evaluating the banking efficiency of Sri Lanka at the national level is presented in this chapter. The previous chapter detailed the methodological framework used to address this study's research questions. In line with the research questions presented in Chapter 1, the empirical analysis focuses on the following main tasks:

- Evaluating changes in the technical efficiency of the banking sector of Sri Lanka before and after the end of the armed conflict.

- Comparing changes in banking efficiency across bank groups based on ownership.

- Assessing the impact of the branch expansion, geographical dispersion and other key environmental factors on the efficiency of Sri Lankan banks.

- Evaluating productivity changes in the banking sector.

In order to conduct this analysis, a number of measures of efficiency are employed, as explained in the previous chapter. DEA efficiency scores for individual banks are compiled based on the bootstrap simulation technique. Further, this study has adopted a comprehensive and representative weighted aggregate efficiency approach to compare efficiency between different bank groups operating in the country. In addition, the gap between the technology set of the banking groups is analysed using the meta-technology techniques introduced O'Donnell et al. (2008). For this aim, first, the observations are

grouped based on the periods before and after the end of the armed conflict to assess changes in banking sector performance in the post-conflict era. Banks are grouped into three categories with respect to their ownership, namely domestic commercial banks, domestic specialised banks and foreign commercial banks for a comprehensive analysis of the banking sector. The key determinants of banking efficiency are then evaluated using truncated regression models based on the double-bootstrap technique. Productivity changes have also been analysed using the GMPI. The reference period of this analysis is 2006–2014.

The remainder of this chapter is organised as follows. Section 5.2 describes the model specifications and data used for the study. Trends in the performance of Sri Lankan banks are then analysed in Section 5.3. This section compares the technical efficiency and gaps in technology of the banks with respect to post-conflict banking developments. Section 5.4 compares banking performance across the three different groups of banks based on their ownership and scope of the banking business. The truncated regression model based on the double-bootstrap approach is used in Section 5.5 to assess the impact of branch expansion, geographical dispersion and other external factors. Section 5.6 provides a productivity analysis of the banking sector followed by a summary of this chapter in Section 5.7.

5.2   Model specification and data

5.2.1   Model specification

The efficiency of banking institutions can be evaluated with respect to different aspects such as intermediary services provided (that is the production of investments and loans)

and banking operations (focusing on the profit maximisation aspect of banks). Generally, the provision of intermediation services is considered to be the key role played by banks in terms of resource allocation in an economy while matching short-term liabilities with long-term assets (Diamond & Dybvig 1983; Diamond & Rajan 2001; Song & Thakor 2007). This ability of banks to provide intermediation services has been used by Sealey and Lindley (1977) to introduce the intermediation approach which provides a benchmark to identify the inputs and outputs for DEA. Accordingly, most previous studies identified the facilities provided by banking institutions, particularly credit and investment, as the outputs, and identified the resources utilised for the production of banking services such as labour, fixed assets, deposits and other funds as the inputs (Berger et al. 1987; Altunbas et al. 2001; Maudos et al. 2002a; Bos & Kolari 2005; Burki & Niazi 2010; Ray & Das 2010; Sufian 2011a; Sufian 2011b; Arjomandi et al. 2012; Halkos & Tzeremes 2013; Arjomandi et al. 2014; Hou et al. 2014).[72] The operating approach provides measures of the performance of banks in generating revenue as against their expenditure. The literature also recommends the operational approach as a complement to the intermediation approach which does not incorporate revenue in measuring efficiency (Berger & Mester 2003; Arjomandi et al. 2014).

This study, therefore, uses both intermediation and operating (profit-oriented) approaches to evaluate the efficiency of the banking sector at the national level. The sensitivity of the results based upon the intermediation and operating approaches is also evaluated through this analysis.

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[72] Berger and Humphrey (1997), based on their survey of banking efficiency studies, highlighted that the inputs and outputs used to analyse the performances of banks are mostly dependent on the approach employed by the researcher and there is no consensus among researchers about the inputs and outputs for each approach.

5.2.2 Data, inputs and outputs

In this analysis, annual data for the period 2006 to 2014 are pooled to generate a panel of 272 observations. Table 5.1 presents the three bank groups used in the study. All the commercial and specialised banks operating in Sri Lanka are included in the sample. However, new entrants, mergers and exits, along with shortage of reliable information on a few observations have made the dataset unbalanced.

Table 5.1: Number of bank observations by ownership and type

Ownership	2014	2013	2012	2011	2010	2009	2008	2007	2006
CB	12(12)	12(12)	12(12)	12(12)	11(11)	11(11)	11(11)	11(11)	11(11)
DSB	9(7)	9(9)	9(9)	9(9)	9(9)	9(7)	9(7)	9(6)	9(6)
FCB	12(12)	12(12)	12(12)	11(11)	11(11)	11(10)	11(10)	11(11)	11(11)
All	33(31)	33(33)	33(33)	32(32)	31(31)	31(28)	31(28)	31(28)	31(28)

Notes: 1) DCB – domestic commercial banks; DSB – domestic specialised banks; FCB – foreign commercial banks. 2) Numbers of banks included in the sample are provided in brackets.

In measuring the efficiency of intermediation services provided by banks, four inputs and two outputs were taken into account. The number of employees (x_1), fixed assets (x_2), total deposits (x_3) and borrowed funds (x_4) are the inputs, while total advances (y_1) and investments (y_2) are considered as outputs. Efficiency measures derived from the profit-oriented approach are based on two inputs and two outputs: total interest expenses (x_5) and non-interest expenses (x_6) as inputs and total interest income (y_3) and non-interest income (y_4) as outputs. The descriptive statistics of the input and output variables used in both approaches are presented in Table 5.2. The high dispersion of the data relating to each variable is mainly due to small banks which maintain only one or very few branches within the country.

Table 5.2: Inputs and outputs used in measuring efficiency

Input/output	Mean	Median	Standard Deviation	Minimum	Maximum
Intermediation approach					
Employees (x_1)	1,521	470	2,238	9	9,645
Fixed Assets (x_2)	1,104	271	1,803	3	8,475
Deposits (x_3)	59,932	10,196	97,786	44	488,930
Borrowings (x_4)	13,834	3,349	24,660	1	168,301
Advances (y_1)	51,641	11,509	83,368	345	461,935
Investments (y_2)	22,450	4,409	42,761	1	274,753
Operating approach					
Interest Expenses (x_5)	5,037	1,120	8,047	14	42,018
Non- Interest Expenses (x_6)	2,405	729	3,648	34	27,782
Interest Income (y_3)	8,425	1,955	12,536	119	63,674
Non-Interest Income (y_4)	1,437	416	2,181	1	18,272

Note: All the values are in Sri Lankan rupees (million) except the number of employees. The Colombo consumer price index (CCPI) of Sri Lanka has been used to derive inputs and outputs in 2006 prices by deflating current values.

Source: Author's calculations

5.3   Trends in Sri Lanka's banking sector performance

After the end of the armed conflict in 2009, favourable macroeconomic conditions prevailed in the country, with healthy economic growth and an improvement in investor sentiment (CBSL 2009). Although Sri Lankan banks were not directly affected by the GFC, the banking sector recorded a dismal performance during this period mainly due to a deceleration in external trade (CBSL 2009).[73] In addition to external influences, the efficiency of the banking sector may also have been influenced by internal changes in the banking sector during the reference period such as branch expansions. In the post-conflict period, Sri Lanka's banking sector also recorded a significant expansion in terms of its

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[73]Growth of the export-oriented manufacturing sector of the country decelerated mainly due to the poor economic performances during the period of the GFC in the United States and European countries, the major export destinations of Sri Lanka. The banking sector also experienced a decline in revenue and an increase in NPAs with the deceleration in exports and increased raw material imports.

geographical dispersion and the number of branches. Overall, there was a significant change in the economic environment after 2009 due to all of the abovementioned factors. Therefore, in this section, the efficiency of Sri Lankan banks is analysed before and after the end of armed conflict to examine changes in banking sector performance during these two periods.

5.3.1   Changes in banking efficiency before and after the end of the conflict
    Comparison based on average efficiencies and Li-test

The averages of bias-corrected efficiencies of the banking sector for the period 2006–2014 are presented in Figure 5.1. As discussed in the methodology chapter, a technical efficiency score equal to unity means that a bank is "fully" efficient, and where technical efficiency values are higher than unity, the bank is relatively inefficient. Thus, the higher this value, the more inefficient the bank is. Panel A of Figure 5.1 shows that although intermediation inefficiency decreased to some extent up to 2009, it declined sharply between 2010 and 2011. This increase in inefficiency could be due to the increased capital and labour inputs to produce banking services after the end of the armed conflict in 2009. However, a considerable decline in intermediation inefficiency can be observed after 2011, which could be seen as a salutary move of banking performance in the post-conflict era.

A similar trend of efficiency change can again be seen under the profit-oriented operating approach in Panel B of Figure 5.1 for the same period. It is also worth noting that higher operational inefficiency was recorded during the rapid expansion in the banking sector at the beginning of the post-conflict era in 2010–2011 relative to the period 2012–2014.

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Figure 5.1: Changes in efficiency of the Sri Lankan banking sector (2006–2014)

Intermediation Approach

Panel A

Operating Approach

Panel B
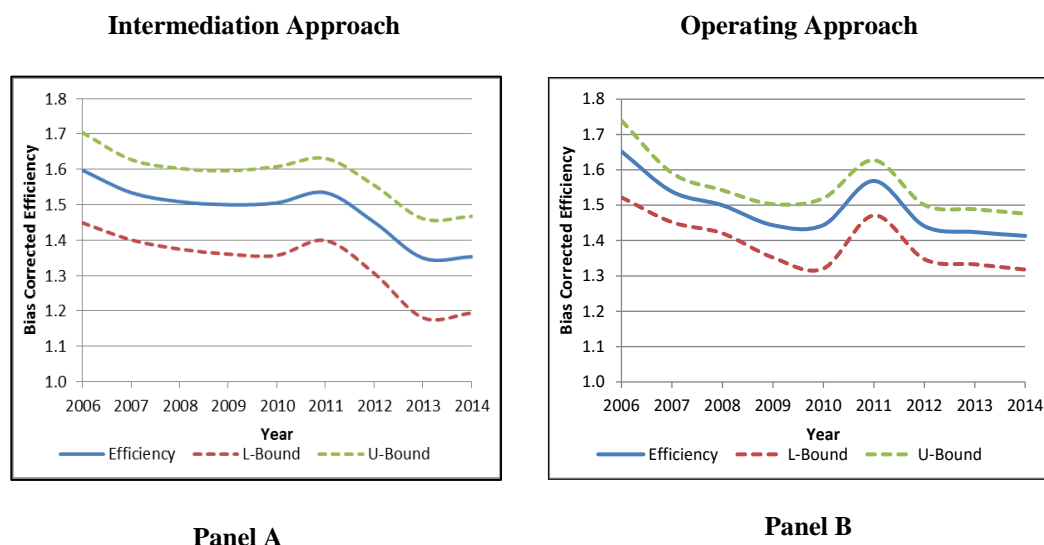
Source: Author's calculations

Intermediation efficiency between the two periods 2006–2009 and 2010–2014 is also evaluated using the Li test which compares the equality of densities of two random variables. In assessing the effciency of the banks based on densities of the efficiency estimations, the sample is divided into two groups covering: the period before (2006–2009) and the period after the end of the armed conflict (2010–2014). The test statistics and the *p*-values of the Li test for comparing the distribution of banking efficiencies in the two periods are provided in Table 5.3. The graphical presentation of densities of intermediation and operating approaches are also shown in Figure 5.2. The graphical presentation of intermediation efficiencies in Panel A of Figure 5.2 does not show a clear difference in efficiency scores for the periods 2006–2009 and 2010–2014. However, according to the test statistics in Table 5.3, the null hypothesis of equality in the distribution of efficiency scores relating to the two time periods 2006–2009 and 2010–2014 is rejected at the 1% level. This indicates significant changes in the intermediation efficiencies between these periods. The Li test provides similar results when the analysis

is restricted to the commercial banks reflecting the homogeneity in the sample of both commercial banks and specialised banks (see Table F.1.1 in Appendix F).

Figure 5.2 : Visualisation of Kernel-estimated densities of efficiency scores 2010–2014 and 2006–2009

Intermediation approach   **Operating approach**

Panel A   Panel B
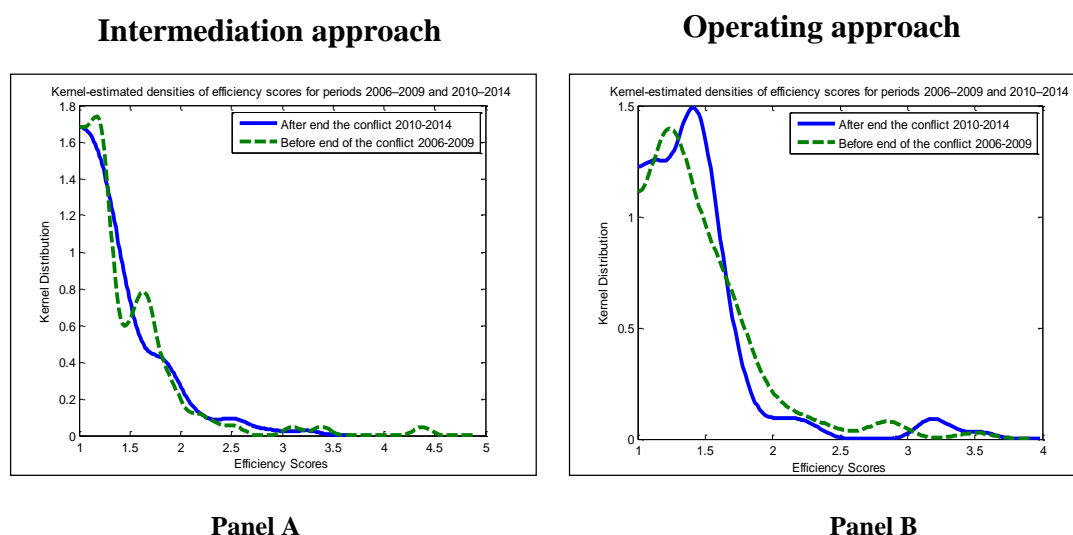
Source: Author's calculations

Table 5.3: Comparison of banking efficiency before and after the end of the conflict based on the Li test

	Li Test Statistic	*P*-value	Decision on *Ho* (at 5% sig. level)
Intermediation approach			
f1(Year 2010–2014) = f1(Year 2006–2009)	3.0510***	0.0015	Reject *Ho*
Operating approach			
f1(Year 2010–2014) = f1(Year 2006–2009)	2.4589**	0.0160	Reject *Ho*

Note: The Li Test Statistics with *** are significant at the 1% level and ** when significant at the 5% level.

Source: Author's calculations

The Li test results also provide evidence of significant differences in operational efficiencies between these two periods at the 5% level. This is also reflected by the visualisation of the kernel densities of efficiency scores as in Panel B of Figure 5.2. These significant differences between operational efficiency between the two periods are not observed when the specialised banks are excluded from the analysis (see Table F.1.1 in

Appendix F). However, the Li test only provides preliminary evidence of significant differences in bank efficiencies between the two periods. Therefore, the aggregate efficiency technique is used to further analyse and compare banking performance in the two periods.

Comparison based on aggregate-efficiencies

As explained in the methodology section, Färe and Zelenyuk (2003) and Simar and Zelenyuk (2007) introduced aggregated efficiencies incorporating output weights to compare two groups of firms in a DEA context. This provides a comprehensive framework for comparing the performance of the two groups when considering their weight in output, assuming heterogeneity between the groups and allowing for homogeneity within each group.

Accordingly, aggregate efficiencies are used to assess changes in banking sector performance in the post-conflict period. The aggregate efficiency concept is different from the conventional average (mean) efficiency measures and it is ideal for comparing the efficiency changes in the banking industry across the periods assuming unvarying best-practice technology without significant technical progress or regress. Different conclusions can be obtained from these two efficiency measures (average efficiency and aggregate efficiency) due to heterogeneity in the size and performances of banks in the sample.

As in the previous section, the original sample was divided into two non-overlapping time-period groups (the post-conflict era and the period before the end of the conflict) to derive the aggregate and mean efficiencies of the banking sector (Table 5.4). The lower

aggregate efficiency scores for the post-conflict period under both operating and intermediation approaches suggest improvements in efficiency in this period. Further, the non-overlapping confidence intervals of aggregate efficiency for the two periods indicate that this improvement is significant at the 5% level. Therefore, it can be argued that banking performance has been enhanced during the post-conflict period at the industry level. This improvement is also reflected in the lower unweighted simple average of efficiency in the post-conflict period, although this increase is not significant due to overlapping confidence intervals. Further to the confidence intervals of aggregate and mean efficiencies, bank performance between these two periods has also been evaluated using point estimate RD statistics. RD statistics are based on the ratio of bank efficiencies between two periods. Further, RD statistics are derived with respect to the mean efficiencies and aggregate efficiencies of two periods.

Table 5.4: Comparison of aggregate and mean efficiencies of banks before and after the end of the conflict

Statistics	Bias-Corr. Estimates	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
Aggregate efficiency (2010–2014)	1.171	0.015	1.131	1.188
Aggregate efficiency (2006–2009)	1.309	0.034	1.227	1.351
Mean-efficiency (2010–2014)	1.534	0.049	1.425	1.596
Mean-efficiency (2006–2009)	1.702	0.065	1.550	1.781
Operating approach				
Aggregate efficiency (2010–2014)	1.256	0.027	1.195	1.299
Aggregate efficiency (2006–2009)	1.435	0.054	1.320	1.521
Mean-efficiency (2010–2014)	1.544	0.064	1.403	1.651
Mean-efficiency (2006–2009)	1.677	0.076	1.512	1.805

Source: Author's calculations

Table 5.5 provides RD statistics and its 95% confidence intervals of aggregate and mean banking efficiencies for the periods before and after the end of the armed conflict with

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respect to both the intermediation and operating approaches. The RD statistic for 2010–2014 vs. 2006–2009 is found to be 0.887 under the intermediation approach and 0.846 under the operating approach. It is also observed that unity ("1") is not included in the 95% confidence interval. These results indicate the industry's performance improvements in the post-conflict era and they are in line with the results of the Li test in the previous section. This improvement can also be observed when the analysis is only focused on the commercial banking sector (see Table F.1.2 in Appendix F).

Table 5.5: Comparison of banking efficiency before and after the end of the conflict based on RD statistics

Statistics	Bias-Corr. Estimates (RD-statistic)	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
RD_aggregate (2010–2014 vs 2006–2009)	0.887***	0.028	0.840	0.950
RD_mean (2010–2014 vs 2006–2009)	1.0002	0.053	0.887	1.1147
Operating approach				
RD_aggregate (2010–2014 vs 2006–2009)	0.864***	0.048	0.772	0.955
RD_mean (2010–2014 vs 2006–2009)	0.975	0.074	0.822	1.114

Note: The ratios of aggregate efficiency (RD_aggregate) and mean efficiency (RD_mean) with *** meaning significance at the 1% level.

Source: Author's calculations

5.3.2 Analysis of the technology gap before and after the armed conflict

Due to the change in macroeconomic conditions and the reforms in the banking sector, along with regulatory changes, it is expected that the banking sector experienced different production opportunities after the end of the armed conflict in 2009. Therefore, the meta-frontier framework of O'Donnell et al. (2008) is adapted to evaluate the technology gap in the banking sector in the post-conflict era compared to that of the period before the end

of the conflict.[74] Meta-frontier analysis provides a framework to compare the technology set used by the banking industry across these periods based on their group (period 2006–2009 and 2010–2014) frontiers and a common best possible meta-frontier (period 2006–2014). The efficiency calculated based on the meta-frontier is decomposed into the common measure of technical efficiencies based on the group frontiers and the technology differences based on the gap between each group frontier and the meta-frontier. This gap is defined as MTR and it is used to evaluate the changes in the technology sets of the banking industry before and after the end of the armed conflict in Sri Lanka.

Table 5.6 provides the MTRs based on both conventional and bias-corrected efficiency scores for the periods 2006–2009 and 2010–2014. According to these findings, MTRs for the period 2010–2014 are greater than the MTRs for 2006–2009 with respect to both the intermediation and operating approaches. Accordingly, the group frontier of the period 2006–2009 is located further from the meta-frontier than the group frontier of the period 2010–2014. This is evidence of a gap in the technology set used by the banks before and after the end of the armed conflict and an improvement in the technology set used in the post-conflict era. This technology gap is more prominent in the operational approach than the intermediation approach. This improvement in technology set could be due to the conducive environment for banking business which prevailed in the country during the post-conflict era. A number of prudential measures have also been taken by the CBSL to enhance the soundness of the financial sector and improve the risk management strategies during this period (CBSL 2009; 2010; 2013a; 2014).

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[74] O'Donnell et al.(2008) specifically mentioned that the meta-frontier analysis is valid when the technology sets vary over time, although the concept is introduced for the cross sectional variation in technology sets.

A similar improvement in the technology set can also be observed when the analysis is restricted to the commercial banking sector which dominates the financial sector of Sri Lanka (see Table F.1.3 in Appendix F).

Table 5.6: MTRs of Sri Lankan banks before and after the end of the armed conflict

Period (Years)	Intermediation Approach		Operating Approach	
	Mean MTRs	Bootstrap Mean MTRs	Mean MTRs	Bootstrap Mean MTRs
2010–2014	0.9296	0.9029	0.9968	0.9990
2006–2009	0.8355	0.7769	0.8586	0.8246

Source: Author's calculations

5.4 Bank groups and performance

The literature highlights the possible influences of ownership and of the scope of the banking business on the performance level of banks (Isik & Hassan 2002; Berger et al. 2005; Bos & Kolari 2005; Fries & Taci 2005; Grigorian & Manole 2006; Havrylchyk 2006; Burki & Niazi 2010; Bokpin 2013). Therefore, a comparison of efficiency levels across these groups is important for a comprehensive analysis of banking performance. As explained in Chapter 2, the Sri Lankan banking sector comprises both foreign and domestic banks. All the foreign banks operate as commercial banks. The domestic banks can be further categorised into commercial and specialised banks.

Overall, three main differences can be observed between commercial and specialised banks. First, the scope of services offered by specialised banks is more limited than the scope of the services provided by commercial banks, as some of the banking activities such as accepting demand deposits and facilitating international trade are not allowed for such banks. Second, scales of operation for specialised banks are smaller than for the

domestic commercial banks. Specialised banks are mainly involved in household sector saving mobilisation and loan disbursement, development finance and SME finance. Third, in general, domestic commercial banks have wider geographically dispersed branch networks than the specialised banks. This study provides an assessment of changes in banking sector performances across foreign commercial, domestic commercial and domestic specialised bank groups during the period 2006–2014.

5.4.1   Changes in banking efficiency across ownership

Comparison based on Li-test and Kernel densities using unweighted efficiencies

Table 5.7 presents the results from the Li test which was used to compare the distribution of densities of the intermediation and operational efficiency estimations between the three bank groups. Results from the Li test provide evidence of inequality in the distributions of efficiency scores between domestic banks and foreign banks, which means the null hypothesis is rejected. This is further confirmed by the visualisation of the Kernel densities of the efficiency scores in Figure 5.3 showing an evident difference between the efficiency densities of the domestic and foreign banks. The differences between performance levels of the domestic and foreign commercial banks with respect to the Li test are more prominent when the analysis is focused only on commercial banks confirming the above findings (see Table F.2.1 in Appendix F).

Table 5.7: Comparison of efficiency between bank groups by ownership based on the Li test

H$_0$(f is kernel densities)	Li Test Statistic	P-value	Decision on Ho (at 5% sig. level)
Intermediation approach			
f1(Foreign Banks) = f1(Domestic commercial)	4.451***	0.001	Reject *Ho*
f1(Domestic Banks) = f1(Specialised)	-0.583	0.334	Do Not Reject *Ho*
f1(Foreign Banks) = f1(Specialised)	2.866***	0.003	Reject *Ho*
Operating approach			
f1(Foreign commercial) = f1(Domestic commercial)	5.628***	0.000	Reject *Ho*
f1(Domestic commercial) = f1(Specialised)	0.232	0.763	Do Not Reject *Ho*
f1(Foreign commercial) = f1(Specialised)	4.687***	0.000	Reject *Ho*

Notes: The Li Test Statistics with *** are significant at the 1% level and ** when significant at the 5% level.

Source: Author's calculations

Comparison based on aggregate-efficiencies

The mean and aggregate efficiencies of the three bank groups are presented in Table 5.8. Aggregate inefficiencies of both domestic bank groups are lower than those of the foreign banks. These results indicate the existence of a superior performance of domestic commercial banks and specialised banks compared to foreign banks under the intermediation approach.

Figure 5.3: Visualisation of Kernel-estimated densities of efficiency scores for domestic and foreign banks

Intermediation approach

Operating approach

Panel A

Panel B
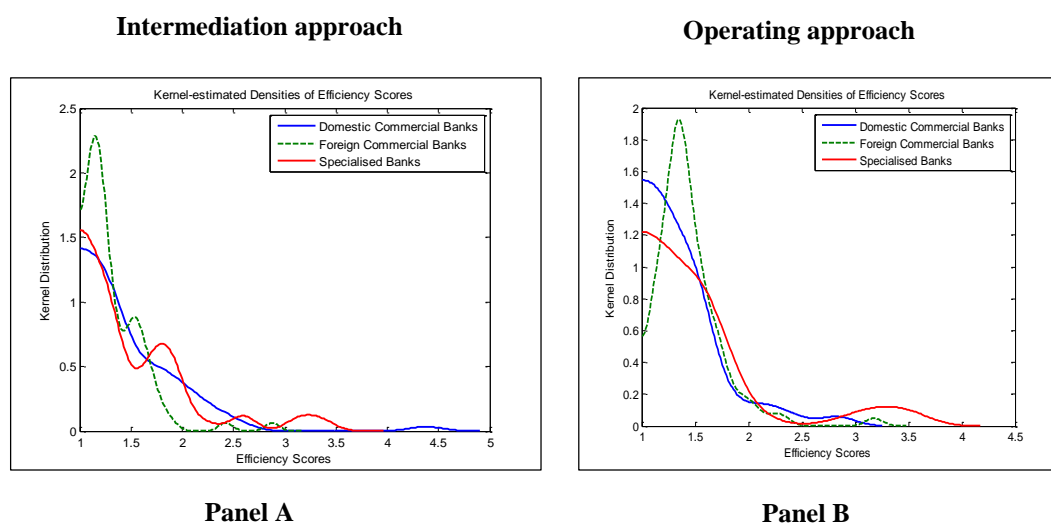
Source: Author's calculations

Table 5.8: Aggregate and mean efficiencies of bank groups by ownership

Statistics	Bias-Corr. Estimates	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
Aggregate efficiency (Foreign commercial)	1.210	0.037	1.269	1.358
Aggregate efficiency (Domestic commercial)	1.110	0.019	1.138	1.179
Aggregate efficiency (Specialised)	1.145	0.035	1.170	1.256
Mean-efficiency (Foreign commercial)	1.371	0.054	1.508	1.641
Mean-efficiency (Domestic commercial)	1.285	0.049	1.340	1.452
Mean-efficiency (Specialised)	1.431	0.102	1.454	1.710
Operating approach				
Aggregate efficiency (Foreign commercial)	1.209	0.022	1.155	1.243
Aggregate efficiency (Domestic commercial)	1.349	0.037	1.269	1.410
Aggregate efficiency (Specialised)	1.272	0.059	1.126	1.342
Mean-efficiency (Foreign commercial)	1.554	0.063	1.421	1.654
Mean-efficiency (Domestic commercial)	1.564	0.070	1.408	1.688
Mean-efficiency (Specialised)	1.656	0.132	1.362	1.875

Source: Author's calculations

The RD statistics presented in Table 5.9 (based on the aggregate efficiencies of each bank group) also confirm these results. Higher efficiency in domestic banks has been explained in the literature as an outcome of a poor regulatory environment in developing countries

which limits the performance of foreign banks (Berger & De Young 2001; Berger 2007). The poor performance of foreign banks is also explained by some studies using the so-called "home field advantage" hypothesis which identifies low efficiencies caused by: lack of knowledge of the local market and socio-economic conditions; informational asymmetries; and difficulties in establishing networks (Bhattacharyya et al. 1997; Buch 2003; Das & Ghosh 2006; Bhattacharyya & Pal 2013).

Table 5.9: Efficiency comparison of bank groups by ownership based on RD statistics

Statistics	Bias-Corr. Estimates (RD-statistic)	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
Foreign vs Domestic Commercial Banks				
RD_aggregate (Foreign commercial/Domestic commercial)	1.160***	0.035	1.079	1.218
RD_mean (Foreign commercial /Domestic commercial)	1.305***	0.055	1.178	1.399
Foreign vs Specialised Banks				
RD_aggregate (Foreign commercial /Specialised)	1.086**	0.042	1.000	1.174
RD_mean (Foreign commercial / Specialised)	0.972	0.079	0.837	1.156
Domestic vs *Specialised* Banks				
RD_aggregate (Domestic commercial / Specialised)	0.931	0.034	0.879	1.011
RD_mean (Domestic commercial / Specialised)	0.711***	0.081	0.582	0.888
Operating approach				
Foreign vs Domestic Commercial Banks				
RD_aggregate (Foreign commercial /Domestic commercial)	0.891***	0.034	0.828	0.955
RD_mean (Foreign commercial /Domestic commercial)	1.060	0.067	0.913	1.180
Foreign vs Specialised Banks				
RD_aggregate (Foreign commercial / Specialised)	0.948	0.051	0.869	1.064
RD_mean (Foreign commercial / Specialised)	0.927	0.096	0.730	1.102
Domestic vs Specialised **Banks**				
RD_aggregate (Domestic commercial / Specialised)	1.062	0.059	0.956	1.193
RD_mean (Domestic commercial / Specialised)	0.866	0.102	0.656	1.057

Note: The ratios of aggregate efficiency (RD_aggregate) and mean efficiency (RD_mean) with *** and ** meaning significance at the 1% and 5% level respectively.

Source: Author's calculations

In the context of Sri Lanka, this finding can be expected mainly due to the fact that foreign banks are more profit-oriented than domestic banks. Foreign banks mostly expect substantial revenue from their fee-based services, although the core activities of the banks

are to provide intermediation services to the economy. Justifying this fact, foreign banks perform better than domestic commercial banks based on profit-oriented operational efficiency. However, no significant difference between domestic specialised banks and foreign commercial banks was found with regard to operational efficiencies.

The results are robust when only the domestic and foreign commercial banks are included into the analysis confirming the higher performance in domestic commercial banks with respect to the intermediation approach while foreign banks recorded a better performance with respect to the operating approach (see Table F.2.2 in Appendix F).

Table 5.10: Aggregate and mean efficiencies between private and state-owned commercial banks

Statistics	Bias-Corr. Estimates	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
Aggregate efficiency (Private commercial)	1.098	0.016	1.061	1.118
Aggregate efficiency (State-owned commercial)	1.041	0.014	1.002	1.055
Mean-efficiency (Private commercial)	1.101	0.013	1.071	1.119
Mean-efficiency (State-owned commercial)	1.062	0.020	1.007	1.082
Operating approach				
Aggregate efficiency (Private commercial)	1.262	0.034	1.194	1.315
Aggregate efficiency (State-owned commercial)	1.218	0.036	1.136	1.276
Mean-efficiency (Private commercial)	1.269	0.034	1.200	1.321
Mean-efficiency (State-owned commercial)	1.253	0.042	1.164	1.321

Source: Author's calculations

In order to evaluate differences in performance between state-owned and privately-owned banks, the sample group of domestic commercial banks was divided into two groups: private commercial banks and state-owned commercial banks. Two fully state-owned commercial banks (Bank of Ceylon and Peoples Bank) are in the state-owned category and the other 10 commercial banks are in the private category. The state-owned commercial banks account for one-third of the banking industry of Sri Lanka with respect to total assets. The aggregate efficiencies and mean efficiencies are presented in Table

5.10 for both intermediation and operational services. The results reveal higher mean and aggregate efficiencies in state-owned commercial banks than in the private commercial banks.

The RD statistics derived from the ratio of the aggregate and mean efficiencies of the two bank groups are presented in Table 5.11. In line with the aggregate and mean efficiencies presented in Table 5.10, the results show higher aggregate efficiencies of state-owned banks compared to private commercial banks (RD is greater than unity). In particular, with respect to intermediation services, the state-owned banks' aggregate efficiency is significantly higher than that of private commercial banks at the 1% significance level. Overall, this better performance of the state-owned banks could be due to their competitiveness in an environment of limited direct government control. Further, the two state-owned commercial banks may have comparative advantage in the banking market due to their size, the wider coverage of their branch networks and their large customer base.

Table 5.11: Efficiency comparison between domestic commercial bank groups by ownership based on RD statistics

Statistics	Bias-Corr. Estimates (RD-statistic)	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
RD_aggregate (Private commercial /State-owned commercial)	1.055***	0.017	1.018	1.086
RD_mean (Private commercial /State-owned commercial)	0.991	0.019	0.957	1.032
Operating approach				
RD_aggregate (Private commercial /State-owned commercial)	1.037	0.037	0.961	1.112
RD_mean (Private commercial /State-owned commercial)	0.999	0.038	0.919	1.073

Note: The ratios of aggregate efficiency (RD_aggregate) and mean efficiency (RD_mean) with *** meaning significance at the 1% level.

Source: Author's calculations

5.4.2 Analysis of the technology gap across the bank groups

The differences in technology between domestic and foreign banks may exist because their operations have been influenced by a number of factors such as physical stock, human and financial capital, access to foreign exchange and other socio-economic conditions. Therefore, the meta-frontier analysis introduced by O'Donnell et al. (2008) is again used to evaluate the gap in technology used by domestic and foreign banks in Sri Lanka.

According to Table 5.12 the mean MTRs of foreign commercial banks are higher than those of the domestic commercial and specialised bank groups when calculated using the intermediation approach. This indicates that the group frontiers of domestic commercial and specialised banks are located further from the meta-frontier than the group frontier of the foreign commercial banks. This provides evidence that the technology set used by the foreign commercial banks is more advanced than the other two bank groups. In general, foreign banks have shown better cost and risk management than the domestic banks (Lensink et al. 2008). Therefore, foreign banks may have access to better technology sets than their domestic counterparts. Generally, foreign banks have greater access to IT-related resources and risk management techniques used by their holding companies which mostly have a multinational presence and more advanced technologies. Therefore, the higher MTRs recorded by the foreign commercial banks are not surprising. The limitations in business scope of the specialised banks relative to the commercial banks can be a reason for their having the lowest MTR.

With respect to their operating approaches the domestic commercial banks have lower

MTRs than the foreign commercial banks and domestic specialised banks. The higher MTRs recorded by the domestic specialised banks indicate that they have used better technology in profit-oriented operations than the domestic commercial banks. This may be due to their experience in small-scale lending which is mostly associated with lower NPAs. Specialised banks have more experience in generating income through small-scale household and SME sector lending. Geographical expansion enabled all the banks to attract household and SME sector customers. Therefore, specialised banks may have had better income-generating opportunities than domestic commercial banks due to the expansion in the post-conflict era.

The higher technology set of the foreign commercial banks compared to the domestic commercial banks can also be observed when the specialised banks are excluded from the sample (see Table F.2.3 in Appendix F).

Table 5.12: MTRs of bank groups by ownership

Ownership	Intermediation Approach		Operating Approach	
	Mean MTRs	Bootstrap Mean MTRs	Mean MTRs	Bootstrap Mean MTRs
FCB	0.933	0.915	0.942	0.937
DCB	0.825	0.761	0.826	0.827
DSB	0.790	0.711	0.936	0.977

Note: FCB-Foreign Commercial Bank; DCB-Domestic Commercial Banks; DSB- Domestic Specialised Banks.

Source: Author's calculations

5.5   Determinants of banking efficiency in Sri Lanka

This section discusses and evaluates possible determinants of banking efficiency which are relevant to the Sri Lankan banking industry and are also backed by the literature. Branch expansion or geographical dispersion can be seen as an important factor, as   Sri

Lanka has experienced significant expansion in the banking sector particularly after the end of the armed conflict in 2009. The impact of credit risk, liquidity and capital strength on bank efficiency can also be seen as crucial since the country adapted the Basel framework on risk management on a staggered basis during the reference period (CBSL 2012a; 2013a; 2014). Further, some other factors such as GDP growth, profitability, size and time trend are also considered as control variables.

5.5.1 Environmental variables used in the analysis of banking efficiency

As explained in Chapter 3, the environmental variables selected for the national level analysis can be categorised into four main groups, namely: bank-specific variables, business environment variables, macroeconomic variables and socio-demographic variables. However, changes in socio-demographic variables at the national level are not prominent since this study covers only nine years. Therefore, potential efficiency determinants from the other three categories are included into the model. Accordingly, descriptions of the environmental variables employed for the analysis are given below.

Bank-specific variables

Coverage and expansion (COVER & EXP): Geographical dispersion of bank branches and growth (expansion) of branches for each bank are included in the model to assess the impact of banking sector expansion during the reference period. Geographical dispersion is estimated for each bank based on the percentage of bank branches outside the Western region which is the richest region in Sri Lanka, contributing around 42% of GDP and having the highest concentration of bank branches (CBSL 2014). The growth of branches for each bank is proxied by the annual growth in the number of bank branches. During

the period 2006−2014 the banking sector recorded an increase in the number of bank branches of around 60% due to factors including economic expansion, directions issued by the CBSL, and the revival of economic activities in the Northern and Eastern regions after the end of armed conflict.

It should be noted that the distance between the head office and branches is commonly used in the literature as a proxy for the geographical dispersion of bank branches (Deng & Elyasiani 2008; Felici & Pagnini 2008) and the size of branch networks is proxied by the number of bank branches maintained by a particular bank (Pasiouras 2008; Vu & Turnell 2010; Mahathanaseth & Tauer 2014). However, distance from branches to head office and total number of branches maintained by a bank can be correlated with the size of the bank, since big banks are those that mostly maintain wider and larger branch networks. Therefore, the two variables of percentage of branches outside the Western region of Sri Lanka and growth in branch networks are used in this study to avoid the above possible correlations which are also highlighted in the literature (Deng & Elysainai 2008; Felici & Pagnini 2008; Thilakaweera et al. 2016b; Thilakaweera et al. 2016c).

Ownership (OWN): Sri Lanka has a long history of both domestic and foreign ownership in the banking sector. Even in 1948 when Sri Lanka regained its independence, the banking sector comprised both foreign and domestic banks. Unlike most other developing countries which allowed foreign participation in the banking sector only after the implementation of reforms such as participation through limited equity investment, foreign-owned banks have played a role in the Sri Lankan banking industry at different levels and during different periods depending on the economic and political environment. The liberalisation policies introduced in 1977 removed some of the regulatory barriers

imposed on foreign ownership. With the array of reforms implemented in the banking sector, foreign and domestic banks operate in a competitive environment to some extent. Hence, a dummy variable is included in the model as a control variable for changes in efficiency with respect to foreign and domestic ownership. The literature provides mixed results on the ownership-efficiency relationship as explained in Chapter 3 (Altunbas et al. 2001; Demir et al. 2005; Fries & Taci 2005; Berger 2007; Burki & Niazi 2010).

In addition, the Sri Lankan banking sector comprises commercial and specialised banks but the former dominate the industry. Therefore, the model was re-estimated to exclude the specialised banks in order to identify the impact of selected environmental variables on the efficiency of commercial banks. The literature has also divided bank ownership into state and private ownership. However, it is difficult to do this in the case of Sri Lankan commercial banks since some of them are partially owned by the government. Although the government has equity in most domestic commercial banks, all of them maintain private banking practices except the two fully state-owned banks. Therefore, the model was also re-estimated to exclude the two big fully state-owned commercial banks to assess the influence of selected determinants on the efficiency of the other commercial banks.

Total Assets (SIZE): The natural logarithm of total assets is used as a proxy for the size of a bank. Total assets is a widely accepted and commonly used indicator in both academic studies and business analysis practices (Zelenyuk & Zelenyuk 2014). As a variable impacting banking efficiency, researchers can hardly ignore the size of the bank. Results from previous studies, however, are quite ambiguous. Some studies highlight a

negative relationship between bank size and efficiency, emphasising scale inefficiencies (Isik & Hassan 2002). On the other hand, the positive effect of bank size on intermediation efficiency is supported by many studies including Drake et al. (2006) and Hou et al. (2014). Therefore, this relationship may vary across countries depending on their economic environments and regulatory regimes. As the banking sector in Sri Lanka is composed of large and small banks, incorporating bank size in the regression models can be justified.

Variables related to business environment

Total equity capital to total assets ratio (CAP): The equity capital to assets ratio is widely used in the literature as a measure of the capital strength of a bank (Mester 1996; Altunbas et al. 2000; Grigorian & Manole 2006). During the period 2006−2014 the CBSL took measures to implement the Basel II adequacy framework on a staggered basis in line with the framework established by the Basel Committee (CBSL 2012a; 2013a; 2014). The impact of the capital adequacy regulations imposed by the CBSL could be instrumental in changing banking performance since banks have to balance their assets and equity to maintain the capital adequacy ratio set by the CBSL. More recent studies frequently use the equity to assets ratio as an indicator of the capital risk of a bank (Mester 1996; Altunbas et al. 2000; Grigorian & Manole 2006). Based on these developments in the Sri Lankan banking sector and in the relevant literature, the equity to assets ratio is included in the model as a proxy of capital strength. A positive relationship is expected between the capital ratio and efficiency assuming that having a higher capital base improves banking performance.

Nonperforming advances (NPA): The NPA to total advances ratio is used as a measure of the quality of the product provided by the banking industry (Berger & De Young 1997; Ataullah et al. 2004). Unlike other bank-specific variables, NPA is highly dependent on the business environment and the bank management has limited control on NPA. In addition, the NPA to total assets ratio is also used in the literature as an indicator of credit risk. In the context of the Sri Lankan banking sector, the net NPA ratio was below 5% during the period 2006−2014 except for the years 2009 and 2013. There was an increase in non-performing advances in 2009 due to the GFC which decelerated the country's exports (CBSL 2009). The increase in NPAs in 2013 was mainly due to defaults on loans backed by collateral based on gold subsequent to the sharp decline in gold prices.[75] The NPA ratio is included in the regression model to evaluate the possible impact of NPAs on banking efficiency.

Loans to assets ratio (LOASSETS): A bank's ability to meet its customers' cash needs is defined as bank liquidity. The loans to total assets ratio has an inverse relationship with liquidity and it is included in the regression model as an indicator of the liquidity position of a bank. When the loans to total assets ratio is high, a bank has low liquid assets such as securities and other financial assets. The relationship between liquidity and banking performance has been tested using the loans to assets ratio in the literature (Hasan & Marton 2003; Sufian 2009a). The loans to assets ratio is therefore used as a proxy for liquidity risk in this study. In the context of Sri Lanka, all banks are required to meet the

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[75] In 2013 the pawning advances based on gold accounted for 14.5 per cent of the total lending portfolio of commercial and specialised banks in Sri Lanka (CBSL 2013b). With a sharp decline of gold prices there is a greater tendency amongst borrowers to abandon their gold-backed pawning advances.

statutory requirement of liquidity as per the directions issued by the CBSL (CBSL 2013b; 2013c).

Return on assets (ROA): ROA is an indicator of profitability and is defined as profit before tax divided by the total assets of a bank. It is commonly used as a control variable in efficiency studies of the banking sector. In general, a positive relationship between ROA and efficiency can be expected, particularly when efficiency is calculated based on a profit-oriented operating approach (Das & Ghosh 2006; Fang et al. 2011). However, the literature provides mixed results with respect to the relationship between intermediation efficiency and ROA (Isik & Hassan 2002; Casu & Molyneux 2003; Casu & Girardone 2004; Ataullah & Le 2006). The Sri Lankan banking sector recorded healthy profits during the reference period of the study except for the 2008/2009 period due to the impact of the GFC which decelerated banking profits in line with the deceleration in economic growth of the country. The ROA is included as a control for the relationship between profitability and banking efficiency.

Macroeconomic variables

Real GDP growth (GDPG): The growth-finance literature supports a possible correlation between banking sector performance and economic expansion (Atindéhou et al. 2005; Levine 2005; Ang & McKibbin 2007; Kim & Lee 2007; Demirgüç-Kunt & Levine 2008). The impact of macroeconomic variables on banking efficiency has been tested in the banking literature and researchers often choose GDP or GDP growth as a proxy for economic performance. Both positive and negative relationships between banking efficiency and economic growth have been found in the literature, while some

studies have found no interaction between these two variables (Lozano-Vivas et al. 2002; Fries & Taci 2005; Grigorian & Manole 2006; Kablan 2007; Pasiouras et al. 2009). It seems that the efficiency-growth nexus is different depending upon the context. Therefore, GDP growth is included into the model as a control for the relationship between banking efficiency and economic growth.

Other variables

Time trend (TREND): The time trend variable is included in the model to capture the impact of time varying factors on the technical efficiency of the banks due to the evolving nature of efficiency.

Overall, the selection of environmental variables is mainly based on the empirical evidence and recent developments in the Sri Lankan banking sector. Proxies for capturing the impact of banking sector expansion, risk, overall economic growth, and ownership and time trends are included in the regression models as possible determinants of bank efficiency in Sri Lanka. In sum, in order to evaluate the impact of expansion of branch networks on bank efficiency, the following two explanatory variables have been included in the double-bootstrap truncated regression model against the technical inefficiency of each bank as the dependent variable: 1) the geographical dispersion of bank branches which is defined as the percentage of bank branches or service points located outside the Western region (COVER); 2) branch expansion which is defined as the annual growth in the number of bank branches or service points (EXP) owned by a particular bank. Three variables are included into the model to capture the impact of capital strength, credit risk and liquidity. They are: the ratio of equity capital to total assets (CAP) as an indicator of capital, the non-performing advances (NPA) ratio as an indicator of credit risk, and the

ratio of total loans to total assets (LOASSETS) as an indicator of liquidity. Among the other control variables, real economic growth (GDPG) is included into the model to capture the impact of economic expansion on efficiency. Total assets (SIZE), a commonly used indicator for the size of a bank, is also included in the model. Return on assets (ROA) is also included as an indicator of bank's profitability. Dummy variables for foreign ownership (OWN) and time trend (TREND) are also introduced into the double-bootstrap truncated regression model for controlling other influential factors.

5.5.2 Descriptive statistics of environmental variables

The descriptive statistics of the environmental variables included in the regression model are given in Table 5.13. The variable COVER recorded a minimum value of zero, since some banks do not have branches outside the Western region of the country. Similarly, EXP recorded a minimum value of zero since some of the banks did not open new branches in some years.[76] The higher maximum value recorded for NPAs indicates the high rate of non-performing loans recorded by the poorly performing small licensed specialised government banks (MBSL savings bank and Lankaputhra bank).[77] This was mainly due to these banks providing credit facilities to loss-making state-owned enterprises and political intervention. However, these newly opened institutions account for less than 0.5% of the banking sector with respect to assets. Overall, the banking sector in Sri Lanka recorded a healthy profit while maintaining a less than 7% average net NPA ratio since other banks performed well during the reference period (CBSL 2014).

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[76] Although there were some relocations of branches, negative values were not recorded in the absence of retrenchment of branch networks.

[77] The Sri Lankan government budget for 2016 proposed to amalgamate the Lankaputhra Bank with the Regional Development Bank. The MBSL saving bank was merged with MCSL Financial Services Ltd and the MBSL Merchant Bank in early 2015 and will continue under the brand name "Merchant Bank of Sri Lanka" as per the financial sector consolidation plan adopted by the CBSL.

Expected relationships between selected environmental variables and banking efficiency are also summarised in Table 5.14.[78]

Table 5.13: Descriptive statistics of environmental variables included in the regression models

Variable	Description	Mean	Standard Deviation	Minimum	Maximum
COVER	Number of bank branches outside the Western region as a ratio of total branches	0.41	0.30	0.00	0.88
EXP	Annual growth (expansion) in number of bank branches	0.16	0.79	0.00	12.00
CAP	Capital strength defined as the ratio of total equity to total assets	0.20	0.16	0.00	0.75
NPA	Ratio of non-performing advances (loans) to total loans	0.07	0.10	0.00	0.56
LOASSETS	Liquidity ratio defined as the ratio between total loans and total assets.	0.59	0.19	0.11	0.99
GDPG	Growth of real national GDP (%)	6.83	1.33	3.50	8.20
SIZE	Total assets as a proxy for the natural logarithm of total assets	17.15	1.56	14.19	20.36
ROA	Return on assets as a ratio of profit before tax to total assets	0.03	0.03	-0.05	0.21
OWN	Dummy for foreign ownership	0.64	0.48	0.00	1.00
TREND	Time trend	5.14	2.57	1.00	9.00

Source: Author's calculations

Table 5.14: Expected relationships between environmental variables and inefficiency

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[78] The expected relationships are based upon the majority of literature discussed previously. However, these are general expectations and the expected relationship can also be dependent on the country, region and the influence of other factors.

Environmental variable	Expected relationship
COVER	Positive
EXP	Positive
CAP	Negative
NPA	Positive
LOASSETS	Positive
GDPG	Positive
SIZE	Negative
ROA	Negative

Note: The dependent variable is the technical inefficiencies (Farrell's efficiency scores) recorded by the banks. A negative relationship between an environmental variable and the dependent variable suggests the environmental variable improves efficiency. On the other hand a positive relationship suggests the environmental variable reduces efficiency.

Source: Author's classification

5.5.3   Analysis of the environmental variables

This section explores the relationship between the technical efficiency of banks in   Sri Lanka and the set of environmental variables selected for this study. This relationship is tested using both intermediation efficiency and the profit-oriented operating efficiency of the banks. Three regression models were used for a comprehensive analysis of the relationship between environmental variables and efficiency based on both intermediation efficiency and the profit-oriented operating approaches. The results are presented in Table 5.15. The FULL model is estimated based on all licensed commercial banks and specialised banks operating in Sri Lanka. Commercial banks play a key role in the financial sector and the economy overall with their capacity in a wide range of banking business. Therefore, specialised banks are excluded from the sample for the COM model with the aim of testing the relationship between environmental variables and the banking efficiency of commercial banks. This provides an opportunity for a comparison between the overall banking sector and the commercial banks with respect to the environmental variables. The COM-GOV model comprises all the commercial banks except the two fully state-owned banks which account for 30% of banking assets in Sri Lanka. Despite

liberalisation of the banking sector and a competitive market environment, the fully state-owned commercial banks still experience government involvement such as in providing credit to government and implementing government loan schemes. Although the government owns a majority of the shares in some other listed commercial banks, they mostly operate as private banks.

As discussed earlier, Farrell's efficiency scores presented in this study are higher than unity when a bank is relatively inefficient. Thus, a positive value for a coefficient indicates a positive influence on inefficiency or a negative influence on efficiency. Similarly, a negative sign for a coefficient indicates a negative influence on inefficiency or a positive influence on efficiency. In the interpretation of the results from the following models the influence on efficiency, rather than the influence on inefficiency, is explained.

Geographical dispersion (COVER) and expansion in branch networks (EXP)

Results for the FULL model indicate that the dispersion of branch networks (COVER), as measured by the percentage of bank branches outside the Western region, does not influence the intermediation efficiency of banks in Sri Lanka. In addition, an expansion of branch networks (EXP), as measured by the annual increase in the number of branches, does not influence efficiency. However, the COM model is based on commercial banks only and indicates a positive influence on intermediation efficiency by expansion of branch networks at the 10% significance level. This positive impact is also significant when the two state-owned commercial banks with the highest geographical presence are excluded from the model. It seems that the expansion of branch networks has positively influenced commercial banks. One possible explanation could be that the commercial

banks were able to improve their intermediation efficiency by branch expansion due to the higher demand for credit which prevailed particularly during the post-conflict period. Hence, it may be argued that commercial banks are well positioned with the expansion in branch networks.

A decline in the intermediation efficiency of commercial banks due to branch expansion is claimed by a majority of the literature (Berger et al. 1997; Battese et al. 2000; Berger & De Young 2006). Some studies, however, have also identified an increase in the volume of banking services due to branch expansion as being a factor which improves banking efficiency (Berger & De Young 2001; Bos & Kolari 2005; Pasiouras 2008; Mahathanaseth & Tauer 2014). The results in Table 5.15 reveal a positive relationship between the growth in the number of branches and the efficiency of banks. Hence, one may argue that the negative impact of the branch expansion on efficiency is offset by an expansion in demand for banking services due to healthy economic growth.

In contrast, the geographical expansion of branch networks had a positive relationship with bank efficiency at the 5% significance level based upon operational efficiency when all the specialised and commercial banks are included. However, geographical expansion in branch networks is not associated with operational efficiency changes when the sample is limited to commercial banks. Further growth in branch networks does not show any significant relationship with the operational efficiency of banks in Sri Lanka.

Capital strength (CAP)

According to the regression results, the ratio of equity capital to assets is positively related to the intermediation efficiency of banks at the 1% significance level with respect to all

the banks and to the commercial banks separately. During the period 2006–2014 the CBSL took measures to implement the Basel II capital adequacy framework (CBSL 2012a; 2013a; 2014). The capital ratios of most Sri Lankan banks are much higher than the capital adequacy requirement imposed by the CBSL (CBSL 2010; 2014). Therefore, the positive relationship between the equity ratio and banking efficiency is not surprising. The literature also supports a positive relationship between the capital ratio and the efficiency performance of banks. Mester (1996) argued that a higher ratio of shareholders' capital in banks prevents a moral hazard problem since the management of banks with a high capital ratio experience higher shareholder scrutiny than banks with a lower capital ratio. This was confirmed by Altunbas et al. (2000) for the Japanese banking system. A positive relationship between banking efficiency and the capital ratio is also explained by the ability of well capitalised banks to attract deposits (Grigorian & Manole 2006).

Under the operating approach, the equity ratio of the banks is significant at 1% in all three models. However, the relationship between operational efficiency and the equity to assets ratio is positive in the FULL model which includes all the banks in Sri Lanka, while a negative relationship is recorded for the COM and COM-GOV models based on only the commercial banking sector. This indicates a negative influence of the equity ratio on the efficiency of commercial banks with respect to their operations. Therefore, continuous directions on the capital requirements of the commercial banks issued by the CBSL may be exerting downward pressure on the banking sector operating efficiency of the country.

Non-performing advances (NPA)

The NPA ratio, as measured by the ratio of non-performing advances to total advances including loans, is found to be positive under the intermediation approach. This relationship is significant at 5% for all three models. Although these findings are not endorsed by the mainstream literature, some comprehensive studies of banking efficiency support the existence of a positive relationship between NPA and efficiency under some circumstances (Berger & De Young 1997; Hou et al. 2014). In the Sri Lankan context, this positive relationship could be mainly due to a virtually zero level of NPAs in small banks, particularly those with foreign ownership. A positive relationship between NPA and efficiency is also observed under the operating approach.

Loans to assets ratio (LOASSETS)

The ratio of total loans to total assets reveals a positive relationship with intermediation efficiency and is statistically significant for all models. It appears that banks with a larger share of loans in their portfolio are more efficient than those with a larger share of other assets such as investments and securities. This was not unexpected as banks providing loans are in a position to expand their asset portfolios and the loan interest rate is higher than the interest received from investment in general. In addition, these findings are in line with the efficient market hypothesis which explains higher efficiency as an outcome of a larger share of the loan (credit) market. Findings from this study are in line with previous studies which have incorporated similar indicators as determinants of banking efficiency (Hasan & Marton 2003; Sufian 2009a; Hou et al. 2014).[79]

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[79] The loans-to-assets ratio has been used in some studies as an indicator of liquidity. Higher loans-to-assets ratios indicate lower levels of liquidity.

Operational efficiency is also positively associated with the ratio of total loans to total assets. This positive relationship may be an outcome of returns on loans being higher than returns on other investments in the low NPA environment. Banks highly focused on lending can generate more profit in an environment of low NPAs.

Economic growth (GDPG)

The results presented for all the banks (the FULL model) in Sri Lanka do not provide evidence of a significant relationship between intermediation efficiency and economic growth. A negative and significant relationship, however, can be observed between efficiency and economic growth when the sample is restricted to commercial banks (COM-GOV and COM models). A possible explanation could be a continuous expansion in advances in the post-conflict era while the economy was decelerating, particularly after 2011, with some other factors such as a high base year effect, poor performance in some European economies and completion of resettlement activities in conflict-affected areas.[80] However, the Sri Lankan economy showed a healthy performance after 2011 albeit with a decelerating growth rate. Further, the CBSL implemented an expansionary monetary policy during the deceleration period due to lower inflation and this might be a reason why banks improved their intermediation services even though economic growth was slowing. In addition, the cost of expansion in branch networks while the economic growth was slowing may have made economic growth insignificant or negatively significant for intermediation efficiency.

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[80] As explained in Chapter 2, after the end of armed conflict, Sri Lanka recorded over 8% growth in 2010 and 2011. The impetus of the growth was provided by an expansion in agricultural land usage, resettlement activities and revival of economic activities in conflict-affected areas, along with growth in the construction sector mainly due to high public investment. There was a deceleration in growth momentum in later years after stabilisation of the economy in conflict-affected areas with completion of resettlement and utilisation of most of the abandoned agricultural land. In addition, the fragile economic conditions prevailing in Europe negatively impacted economic growth.

The literature provides mixed empirical evidence on the relationship between economic growth and efficiency. Some previous studies support a negative relationship between economic growth and intermediation efficiency while some other studies support the absence of such a relationship (Demirgüç-Kunt & Huizinga 2000; Fries & Taci 2005; Pasiouras et al. 2009; Chan & Karim 2010; Lozano-Vivas & Pasiouras 2010). The regression results also show evidence of the existence of a significant negative relationship between economic growth and the operational efficiency of the banks.

Total assets (SIZE)

All the models reveal a positive relationship between intermediation efficiency and the size of the banks as measured by the natural logarithm of total assets discounted for changes in the price level. These findings reveal that large banks are more efficient in providing intermediation services. Large commercial banks in Sri Lanka, including two state-owned banks, use advanced technology such as online connectivity and wide ATM networks. The two fully state-owned commercial banks also upgraded their systems in the competitive environment prevailing in the country. Access to modern technology and economies of scale might be key drivers of higher efficiency in   Sri Lanka's large banks. Focarelli and Panetta (2003) argue that with their financial strength, large banks improve their performance by adopting the latest cost saving technologies, and fixed costs can be spread among a larger number of branches, exploiting the advantages of economies of scope.

This positive association between efficiency and the size of banks is well supported in the empirical literature (Berger & Mester 2003; Drake et al. 2006; Hou et al. 2014; Salim et al. 2016b). However, Hicks's (1935) Quiet Life Hypothesis supports lower efficiency of large firms, arguing that their management can have a quiet life by maintaining the advantages of market power as a large firm without having to improve their efficiency (Berger & Hannan 1998). Low efficiency in larger banks is also explained by market power in some studies, as a larger market share enables banks to enjoy higher margins from their customers without the need to improve efficiency in a less competitive environment (Isik & Hassan 2002). However, the Sri Lankan banking sector cannot be considered a less competitive market as the Herfindahl-Hirschman Index was in the range of 1200–1300 for the reference period.[81]

A positive relationship between assets and banking efficiency is also confirmed when efficiency is calculated based on the operating approach. This proves that the large   Sri Lankan banks are also efficient in generating revenue relative to their smaller counterparts.

Return on Assets (ROA)

All three models reveal that the relationship between return on assets and the intermediation efficiency of the banks was not significant during the reference period. These results indicate that the intermediation efficiencies of the commercial banks in Sri Lanka are not dependent on their profitability. One possible explanation is a higher focus

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[81] When the concentration of the deposits in banks is measured using the Herfindahl-Hirschman Index, the Sri Lankan banking sector can be considered as somewhat competitive. None of the banks account for over 20% of total banking sector deposits. This can be considered as an outcome of increased private sector participation in the banking industry with the continuation of financial reforms from 1977.

of the banks on expanding their loan portfolios and customer bases, particularly in the post-conflict era, rather than targeting short-term profit maximisation objectives. During the period 2006–2014, most banks were also focused on an expansion of their branch networks which incurred huge cost for the banks although network expansion is a long-term strategy. With all these expansions, improvement in profitability of the banks has been moderated while efficiency improved significantly. Therefore, the absence of a significant relationship between ROA and intermediation efficiency is not surprising.

Nevertheless, a positive relationship between return on assets and efficiency based on the operating approach is shown for all models at the 1% significance level. This positive relationship was expected, since the operating approach is based on a profit-oriented framework in measuring efficiency, which covers all the income and expenditure of the banks. The positive influence of return on assets on efficiency based on the operating approach is also supported by the literature (Das & Ghosh 2006; Fang et al. 2011).

Ownership (OWN)

The dummy variable used to assess the relationship between the intermediation efficiency of banks and ownership is not significant in any model, reflecting the focus of some foreign banks on providing intermediation services while expanding their branch networks, particularly in the post-conflict period. There are two main schools of thought in the literature on the ownership-efficiency nexus. Some studies support the conclusion that foreign banks are more efficient in developing countries relative to domestic banks due to their exploitation of their comparative advantages such as their superior skills, policies and practices (Bhattacharyya et al. 1997; Isik & Hassan 2002; Hasan & Marton

2003; Grigorian & Manole 2006; Zajc 2006). Some other studies claim that foreign banks generally do not outperform their domestic counterparts in developing countries due to a poor regulatory environment and a lack of knowledge of the local market and socio-economic conditions backed by the home field advantage hypothesis (Berger & De Young 2001; Berger 2007; Sufian 2011b). The insignificant association between ownership and intermediation efficiency could be a reflection of a mix of these environmental factors which could influence efficiency across ownership type.

Under the operating approach, a significant difference in efficiency has been observed between domestic banks and their foreign counterparts. These results again suggest that foreign banks are more profit-oriented than their domestic rivals.

Time Trend (TREND)

According to the specified models, there is a significant positive trend in both the intermediation and operational efficiency of banks in Sri Lanka, reflecting an improvement in banking performance over time and confirming the finding in Section 5.3. This was expected as the Sri Lankan economy expanded significantly, generating demand for banking services and new investments with other regulatory reforms.

Table 5.15: Determinants of the efficiency of Sri Lankan banks based on double-bootstrap regression models

Environmental Variable	Intermediation approach			Operating approach		
	FULL Model	COM Model	COM-GOV Model	FULL Model	COM Model	COM-GOV Model
Constant	14.4973***	12.7827***	12.2656***	9.3332***	5.2099***	5.0377***
COVER	-0.1048	0.0293	0.0717	-0.1739**	-0.0448	-0.0251
EXP	-0.1146	-0.6121*	-0.6708*	-0.0547	-0.0544	-0.0685
CAP	-2.8251***	-1.5939***	-1.5868***	-0.9752***	0.4999***	0.5048***
NPA	-1.0785**	-2.6748**	-2.4475**	-1.2595***	-0.7648**	-0.7863**
LOASSETS	-1.3059***	-1.0509**	-1.0558**	-0.5085***	-0.6341***	-0.6437***
GDPG	0.0510	0.1228**	0.1339***	0.0378*	0.0358**	0.0450***
SIZE	-0.7196***	-0.6663***	-0.6420***	-0.4316***	-0.2009***	-0.1930***
ROA	-1.7396	-2.1657	-1.7406	-10.7459***	-11.4754***	-11.5152***
OWN	0.1500	0.2693	0.2660	0.3448***	0.4485***	0.4508***
TREND	-0.0322*	-0.0596**	-0.0624*	-0.0195*	-0.0294***	-0.0336***

Source: Author's calculations

Notes: (1) Coefficients with ***, ** and * indicate statistical significance from zero at the 1%, 5% and 10% levels, respectively; (2) COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend; (3) The estimated confidence intervals are provided in Tables D.1 to D.6 in Appendix D.

Robustness checks

Three robustness checks have been employed in this analysis to find the determinants of technical efficiency in Sri Lankan banks. First, in addition to using the intermediation approach to calculate banking efficiency, this study has also employed the operating approach to measure banking efficiency based on a profit-oriented perspective. The intermediation approach is based on the core service of the banks as the providers of financial intermediation services by matching short-term liabilities with long-term assets (Diamond & Rajan 2001; Song & Thakor 2007). In contrast to the intermediation approach, the efficiency based operating approach measures the banks' ability to maximise revenue. The two approaches enable a comparison of banking performance among groups of banks from different perspectives, providing a holistic view of changes in banking performance.

Second, the technical inefficiency effect model based on SFA established by Battese and Coelli (1995) (the BC model) has been used to assess the robustness of the results from the double-bootstrap regression model. The BC model only permits one output. Therefore, two outputs in each DEA model with respect to the intermediation approach and operating approach are added to generalise the output. Specifically, intermediation output has been taken to be equal to the sum of advances and investments, while output in the operating approach has been taken to be equal to the sum of interest and non-interest incomes. Findings based on the BC model are in line with results derived from the double-bootstrap regression models. The results of FULL, COM and COM-GOV models based on the BC model also revealed that the geographical dispersion and growth in branch networks were not significant determinants of banking performance. Further, a finding

based on the BC model also highlights the environmental variables which are significant in double-bootstrap regression models as influential factors on banking efficiency. The coefficients and significance levels of the FULL, COM and COM-GOV models based on the BC model are given in Table D.7 in Appendix D.

Third, the models based on all the banks (FULL model) were re-estimated for intermediation and operational efficiency without incorporating the insignificant variables as a robustness check to assess the stability of the models. The coefficients of the re-estimated models for intermediation and operational efficiency are presented in Table D.8 and Table D.9 respectively in Appendix D. Reflecting the stability of the model, three variables that were significant in the FULL models for intermediation efficiency, namely CAP, LOASSETS and SIZE, remain significant in all the re-estimated models at the 1% level. Similarly, ten variables significant at the 1% or 5% level in the FULL model based on the operating approach also remain significant in all re-estimated models, albeit with changes in the levels of significance.

This section has evaluated the determinants of efficiency of the banks, assuming a common efficient frontier for all the banks during the reference period. Deviating from this common efficiency frontier, the next section relaxes the assumption of no change in technology in the banking sector throughout the reference period, and analyses the changes in productivity of Sri Lankan banks by assessing a possible dynamic shift in the efficient frontier of banks.

5.6 Changes in banking sector productivity levels

The productivity changes in intermediation and operational processes in the banking sector in Sri Lanka are presented in this section. The sample of banks used for this productivity analysis is a balanced panel. It comprises only 25 banks; 19 of them are commercial banks and there are six specialised banks.[82] The productivity changes for the period 2006–2014 are estimated using the DEA-based GMPI. The productivity change based on the GMPI can also be disaggregated into two constituent components, namely efficiency change (ΔEFF) and frontier shift due to technology change (ΔTEC). The productivity changes can also be disaggregated into different bank groups using geometric means of the productivity estimates for individual banks for the period 2006 to 2014. The indices greater than one indicate progress while indices lower than one indicate a decline in productivity. If the index value is equal to one, this means neither progress nor decline has taken place.

5.6.1 Productivity changes in intermediation services

Table 5.16 presents the productivity changes for the reference period with respect to the intermediation approach. Changes in productivity across the different ownership and types of banks are also presented. Further, productivity changes have also been disaggregated between the periods before and after the end of the armed conflict. As shown in Table 5.15, the banking sector recorded a 3.1% improvement in productivity of intermediation services during the period 2006–2014 (2.5% is due to technological

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[82] Balanced panel data is required to capture productivity over time. The sample used for the efficiency analysis is unbalanced. Out of the 34 banks used in efficiency analysis, only 25 banks consisting of 19 commercial banks and 6 specialised banks have been used to make a balanced panel for the productivity analysis. Eight banks are excluded due to unavailability of data covering full period 2006–2014, new entrants and mergers.

change and 0.6% is due to efficiency change). According to the decomposition of productivity change into efficiency change and technological change, productivity change has mostly come from technological advancements. This was mainly attributed to technology changes during the post-conflict period. O'Donnell et al. (2008) highlight that the technology set used by a firm (in this context a bank) is influenced by the availability of physical, human and financial capital, along with any other physical and socio-economic factors in the environment in which production takes place. Therefore, this favourable technological change in intermediation services provided by the banking sector could be an outcome of the conducive economic environment that prevailed after the end of armed conflict in Sri Lanka. In addition, during the period after the conflict and during the Global Financial Crisis, CBSL was also more concerned about the prudential measures to improve the risk management strategies and corporate management practices in the financial sector. The ability to make money transfers using mobile phones was introduced in the post-conflict period with the establishment of the necessary regulatory background. This enhanced the efficiency of financial transactions in the country. The overall efficiency of the banks has also improved, albeit at a lower rate during the reference period.

When the banks are grouped into domestic commercial, domestic specialised and foreign commercial banks, it becomes apparent that the overall productivity improvements in intermediation services are to a large extent due to the foreign banks. The technological improvements in foreign banks are the main factor in this overall productivity improvement. The foreign banks have made continuous technological progress since 2010. In general, literature supports the use of superior technology by foreign banks

relative to domestic banks (Lensink et al. 2008; Arjomandi et al. 2011). Despite the continual branch expansion, domestic commercial and specialised banks recorded improvements in both technology and efficiency in the post-conflict period. However, while foreign banks recorded increases in technology their efficiency declined in the post-conflict period.

Overall, banking sector efficiency and productivity have increased during the reference period. In the context of Sri Lanka, technological advancement in banks can be expected since the new technological innovations are affordable for most of them due to their financial strength. It seems that banks have been able to exploit the opportunities created by the demand for banking services in the post-conflict era, and the new opportunities have also been positively influenced by shifts in technology. CBSL has also encouraged commercial banks to adopt risk management measures by requiring them to adhere to capital requirements which are in line with Basel directives. The technology shift in commercial banks could be an outcome of the collective influence of all these factors.

Table 5.16: Changes in productivity levels based on the intermediation approach (2006–2014)

Bank Group		2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2006–09	2010–14	2006–14
Domestic	ΔTFP	1.011	0.966	0.867	1.191	1.170	1.037	1.010	1.130	0.946	1.105	1.043
commercial	ΔEFF	1.037	0.987	1.062	1.088	1.002	1.003	0.967	1.058	1.028	1.023	1.025
banks	ΔTEC	0.975	0.979	0.816	1.095	1.167	1.034	1.044	1.068	0.920	1.081	1.017
Domestic specialised banks	ΔTFP	0.689	1.348	0.820	1.015	1.212	1.003	1.176	1.050	0.913	1.088	1.019
	ΔEFF	0.737	1.200	1.117	1.041	0.948	1.108	1.102	0.883	0.996	1.012	1.006
	ΔTEC	0.936	1.123	0.734	0.974	1.278	0.905	1.067	1.189	0.917	1.074	1.012
Foreign banks	ΔTFP	1.283	1.025	0.756	0.735	1.211	1.306	0.993	1.052	0.998	1.040	1.024
	ΔEFF	1.002	0.983	1.032	0.986	0.977	1.020	0.911	0.936	1.006	0.965	0.980
	ΔTEC	1.280	1.042	0.732	0.746	1.240	1.280	1.090	1.124	0.992	1.077	1.045
All banks	ΔTFP	0.995	1.067	0.819	0.982	1.193	1.108	1.042	1.085	0.954	1.080	1.031
	ΔEFF	0.945	1.033	1.065	1.043	0.981	1.033	0.979	0.974	1.013	1.002	1.006
	ΔTEC	1.053	1.032	0.768	0.942	1.216	1.072	1.064	1.114	0.942	1.078	1.025

Note: ΔTFP denotes productivity change; ΔTFP > 1 and ΔTFP < 1 indicate positive and negative TFP changes, respectively. ΔEFF represents technical efficiency change; ΔEFF > 1 and ΔEFF < 1 show an improvement or decline in technical efficiency, respectively. ΔTEC is the technical change component, which measures how much the frontier shifts. It can be > 1 when the technical change is positive and < 1 when it is negative.

Source: Author's calculations

5.6.2 Productivity changes in operational services

Productivity changes in the operational services of the banks are presented in Table 5.17. The trends in productivity changes in profit-oriented operations are somewhat similar to the trend in productivity changes in the intermediation services of the banks as shown in Table 5.16. Based on the geometric means of the productivity changes of all individual banks, the overall productivity increase during this period was 1.7%. This is mainly due to favourable technical changes during the reference period. The disaggregation of productivity changes shows that technical changes in the foreign banks were the major factor bringing about this progress. Other factors highlighted under the intermediation approach, including a conducive market climate and overall expansion in the economy, may have contributed to this technical change in foreign banks. When the productivity change is explored, a marginal improvement in technology can be noticed in the post-conflict period.

An improvement in productivity of intermediation and operating services during the reference period is also recorded when the sample is narrowed down to the commercial banks. Further, it is confirmed that the impetus for the productivity improvement has come from the technological change in foreign banks (see Table F.3.1 and Table F.3.2 in Appendix F).

Table 5.17: Changes in productivity levels based on the operating approach (2006–2014)

Bank Group		2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2006–09	2010–14	2006–14
Domestic commercial banks	ΔTFP	0.962	1.024	1.038	1.024	0.994	1.033	1.018	0.978	1.008	1.009	1.009
	ΔEFF	0.953	1.029	1.031	0.981	1.020	0.913	1.023	1.063	1.004	0.999	1.000
	ΔTEC	1.010	0.995	1.006	1.044	0.974	1.132	0.995	0.920	1.004	1.011	1.008
Domestic specialised banks	ΔTFP	0.840	1.130	1.061	1.119	0.906	0.985	1.035	1.011	1.003	1.009	1.006
	ΔEFF	0.897	0.974	1.043	1.058	0.995	0.889	0.999	1.109	0.970	1.007	0.993
	ΔTEC	0.937	1.160	1.018	1.058	0.910	1.107	1.036	0.912	1.034	1.002	1.014
Foreign banks	ΔTFP	1.247	1.023	1.044	0.922	0.906	1.221	1.036	0.949	1.100	1.001	1.037
	ΔEFF	1.052	0.978	1.008	0.981	1.020	1.049	0.994	0.995	1.012	1.007	1.009
	ΔTEC	1.186	1.046	1.035	0.940	0.889	1.164	1.043	0.954	1.087	0.993	1.027
All banks	ΔTFP	1.012	1.048	1.045	1.012	0.944	1.077	1.028	0.976	1.035	1.006	1.017
	ΔEFF	0.969	0.999	1.027	0.999	1.014	0.948	1.008	1.051	0.998	1.003	1.001
	ΔTEC	1.044	1.049	1.018	1.013	0.931	1.136	1.020	0.929	1.037	1.003	1.016

Note: ΔTFP denotes productivity change; ΔTFP > 1 and ΔTFP < 1 indicate positive and negative TFP changes, respectively. ΔEFF represents technical efficiency change; ΔEFF > 1 and ΔEFF < 1 show an improvement or decline in technical efficiency, respectively. ΔTEC is the technical change component, which measures how much the frontier shifts. It can be >1 when the technical change is positive or < 1 when it is negative.

Source: Author's calculations

The conventional Malmquist TFP index of Caves et al. (1982), with disaggregation by Färe et al. (1994b), was used as a robustness check in estimating productivity change. The conventional Malmquist TFP index also provided somewhat similar results to the GMPI.[83] Productivity and its disaggregated indices using the conventional Malmquist TFP index are provided in Table D.10 and Table D.11 of Appendix D.

5.7   Summary

This chapter analysed changes in the technical efficiency of Sri Lankan banks and identified key determinants of their technical efficiency for the period 2006–2014. Farrell's output-oriented efficiency measures based on DEA were employed to estimate the technical efficiency of the banks. Estimations of technical efficiency were obtained based on both the intermediation and operating approaches. Prior to the analysis of the determinants of the technical efficiency of the banks using double-bootstrap regression models, the performance of banks across the periods before and after the end of armed conflict, and across bank groups (domestic commercial, domestic specialised or foreign commercial), were analysed.

Three techniques were employed for these comparisons. First, a group comparsion for levels of efficiency was conducted using conventional average efficiencies and a test by Li (1996). Then, the aggregate efficiency technique of Färe and Zelenyuk (2003) and Simar and Zelenyuk (2007) was used to compare banking performances across the groups. Third, the meta-frontier technique introduced by O'Donnell et al. (2008) was

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[83] It was not possible to derive couple of individual TFP indices due to the issue of infeasibility under VRS. Therefore unity ("1") was assigned for those couple of individual TFP indices following Tone (2004).

employed to compare the efficiency frontier between these bank groups.

The results revealed an improvement in banking performances in the post-conflict era compared to the period before the end of the conflict. In addition to the increase in average efficiencies in the post-conflict era, evidence for an improvement in performance of the banking industry was provided by the aggregate efficiencies. Further, an improvement in the technology set used by the banking industry in the post-conflict era was also shown by the meta-frontier analysis. Therefore, this improvement in efficiency, which was achieved by exploiting advantages arising from high demand for credit along with economic expansion, can be considered as a peacetime dividend of the post-conflict era.

The results also revealed the higher aggregate efficiency of the intermediation services of the domestic commercial bank group compared to the other two groups. In addition, the technology set used by the foreign commercial banks was found to be more advanced than that of their domestic counterparts. With respect to their operational approaches, domestic banks were found to be relatively inefficient. Foreign banks' efficiency was significantly higher than that of domestic commercial banks. When the performances of the domestic commercial and specialised banks were compared, significant differences in efficiency could not be observed between the two groups. Foreign commercial banks were also found to have more advanced technology than the domestic commercial and specialised banks based on a meta-frontier analysis with respect to the operational approach.

Results from the double-bootstrap truncated regression models revealed that geographical

expansion and branch network growth did not significantly influence bank efficiency when both commercial and specialised banks were considered. In fact, a positive relationship was found between intermediation efficiency and growth in the branch networks of the commercial banks. Policy directions which will promote further expansion while maintaining a high level of efficiency is vital for the Sri Lankan banking sector since the continuation of economic expansion is dependent on maintaining the level of banking efficiency achieved in the post-conflict era. When the operational performances of banks are considered, an expansion in branch networks also exerts a positive influence at the 5% significance level. However, this relationship is not significant when the sample is restricted to commercial banks.

The analysis highlighted the improvement in productivity in the post-conflict era with respect to the intermediation and operational services of the banks. The results revealed that the productivity changes were mainly driven by technology shifts. The technical changes in foreign banks were the major contributor. The higher productivity improvements of commercial banks are also reflected in the findings.

This chapter has provided an indication of the changes in efficiency arising from the geographical dispersion of bank activity, which is one of the major concerns of   Sri Lankan policy makers who have highlighted improving the availability of financial services at the regional level as an important strategy to alleviate regional economic disparities in Sri Lanka. Development economists and global funding organisations such as the IMF and the World Bank, who promote broad-based and inclusive economic policies, would also welcome the finding that there is a regional dimension to financial

sector dispersion and performance. Therefore, the next chapter compares banking efficiency across the nine regions of Sri Lanka.

Chapter 6   Determinants of regional banking efficiency in Sri Lanka

6.1   Introduction

This chapter focuses on analysing the performance of the banking sector in Sri Lanka at the regional level. The preceding chapter analysed the efficiency of the Sri Lankan banking sector at the national level, and a regional level analysis is also vital for comprehensive policy formulation. There is a wider appeal for a regional level assessment of financial sector performance by policy makers, particularly in developing countries, since broad-based and inclusive growth can only be achieved through addressing regional level differences in an economy. On the other hand, Sri Lanka, as an emerging nation, missed out on opportunities to realise its growth potential due to the armed conflict which lasted until 2009 and it is now looking to eliminate regional disparities in the financial sector in order to achieve balanced regional growth. Therefore, an assessment of the efficiency of Sri Lankan banks at the regional level, and an identification of the regional level factors influencing bank efficiency, particularly for the commercial and specialised banks which dominate the financial sector, is both timely and pertinent.

In this regard, an extension of Färe and Zelenyuk's aggregate efficiency measures based on DEA is now used in this study to compare banking efficiency across the nine regions in Sri Lanka.[84] Further, factors influencing regional level banking efficiency are also evaluated using double-bootstrap truncated regression models. The analysis is based on the regional aggregates of a sample of Sri Lankan banks which operate in all nine regions

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[84] Färe and Zelenyuk's aggregate-efficiency measures were used in previous national level studies for comparing the efficiency of two subgroups (Simar & Zelenyuk 2006; Zelenyuk & Zheka 2006; Henderson & Zelenyuk 2007; Simar & Zelenyuk 2007; Demchuk & Zelenyuk 2009; Curi et al. 2013).

in Sri Lanka. The production approach which was introduced by Benston (1965) has since been used by a large number of studies including Sherman and Gold (1985), Camanho and Dyson (2005), Kenjegalieva et al. (2009), Yang (2009) and Paradi et al. (2011) to measure bank efficiency at the regional, single country and cross country levels. It is the approach adopted here. The Sri Lankan banking sector is an ideal case study for research into regional disparities in banking performance of developing countries. The banking sector in Sri Lanka has shown significant geographical dispersion, particularly after achieving lasting peace in 2009 at the end of its armed conflict.

This chapter is organised as follows. Section 6.2 provides descriptive statistics of the inputs and outputs used in this study and the socio-economic diversity across the nine regions. An empirical comparison of banking efficiency across the regions is provided in Section 6.3 with the Western region used as the benchmark against which to compare the efficiency levels across the regions. Section 6.4 evaluates the impact of selected socio-economic variables on the efficiency of the banks at the regional level by incorporating double-bootstrap regression models. A summary of the chapter is provided in Section 6.5.

6.2   Inputs, outputs and regional diversity

This study uses regional level aggregates of financial and operational data for each bank in deriving DEA efficiency scores. The regional office of each bank is considered as the DMU for this analysis. Assessments of efficiency at the regional level using data for the regional aggregates of banks' inputs and outputs enables a more comprehensive regional analysis. Previous regional level banking efficiency studies have mostly employed branch level efficiency scores to compare the banking efficiency of different regions. In addition, regional level banking aggregates are more suitable for deriving efficiency estimates at

the regional level since the objective of the study is to assess banking performance at the regional level in order to develop appropriate policy recommendations.

The production approach used in this analysis treats banks as production units which produce bank products such as advances and deposits. These products are classified as outputs, and the traditional production factors such as land, labour and capital are considered to be inputs. Studies in banking efficiency at the branch level typically use the production approach for assessing banking performance (Bos & Kool 2006; Paradi & Zhu 2013). Berger and Humphrey (1997) also highlighted that the production approach is suitable for branch-level efficiency studies since customer-related funding activities are undertaken by the branches, while investment decisions are generally not under the control of branches.

With technological developments, the bank branches of large banks are interconnected and any branch can access funds in the network. Therefore, financial services provided by one branch/region are not constrained by the input of that branch/region since each branch/region has access to the resources of all branches in the network. For example, the volume of advances provided by a branch is not restricted to the deposits collected by that particular branch, since any branch can lend excess liquidity of the bank via the IT-based branch network. Therefore, the production approach is more appropriate for an analysis of branch or regional level performance relative to other approaches such as the intermediation, value added and operational approaches.[85] Accordingly, the production

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[85] Approaches other than the production approach mostly use deposits and/or expenditure as inputs and advances and/or income as outputs. However, generation of outputs such as advances and income by a branch is not constrained by its inputs such as deposits and expenditure due to inter-branch transactions.

approach is employed for the analysis in this study which is consistent with most branch level literature (Sherman & Gold 1985; Camanho & Dyson 1999; Camanho & Dyson 2005; Porembski et al. 2005; Yang 2009).[86]

As explained in Chapter 4, the methodology chapter, the output-oriented approach, which measures the efficiency of firms by evaluating maximum possible regional level banking output from given inputs, is used in this regional analysis. The output orientated approach assumes that banks are trying to maximise their production from given inputs at the regional level (Banker et al. 1984). Studies in the literature have used output-oriented approaches particularly when the objective of the study is to evaluate the possibilities for expansion and formulate required policies (Paradi & Schaffnit 2004; Kenjegalieva et al. 2009; Yang 2009). Therefore, the output-oriented approach is identified as the most appropriate approach with an aim of formulating policies for expanding regional level banking and improving efficiency. In this assessment, the impact of socio-economic factors on banking performance is also evaluated. Therefore, the diversity of the regions with respect to socio-economic factors is also presented in Section 6.2.2 to support a comprehensive analysis and interpretation of banking performance.

Therefore, adaptation of other approaches such as the intermediation, value added and operational approaches is not possible when the regional aggregates of the same set of banks are used for the analysis.

[86] The popularity of the production approach in branch level efficiency analyses is in line with the regional level analysis of this study, as it avoids the problem of inter-regional transactions in measuring regional level bank performance. In Sri Lanka, bank branches in the rural sector mostly collect deposits and these funds are then disbursed to bank branches in the urban sector. Therefore, the performance in loan disbursement by an urban branch is not dependent on the amount of deposits they collect due to higher mobilisation of deposits from rural banks. This could be due to the lower credit demand coupled with less economic activity in rural areas or inappropriate borrower/collateral evaluation policies of the banks. According to the data used in this study the conflict-affected Northern region recorded the highest deposits per person and lowest loan density rate.

6.2.1 Inputs and outputs

Two input/output specifications are used to measure the production efficiency of banks at the regional level based on two DEA models. In Model 1, total advances (y_1) and deposits (y_2) are used as two outputs while the number of employees (x_1), the number of branches within the region (x_2) and depreciation of fixed assets (x_3) are used as the inputs. Total deposits include fixed deposits, savings and current accounts maintained by a particular bank in a particular region. Advances comprise all types of term loans disbursed by the particular bank in a particular region. Except for the number of employees and the number of bank branches, all other variables are valued in millions of Sri Lankan rupees and deflated by the CCPI.

Financial data is widely used as inputs and outputs for production approach-based analyses due to the absence of non-financial data, and because they are less sensitive to random effects (Denizer et al. 2007; Freixas & Rochet 2008). However, utilisation of non-financial data is recommended in the literature to get a real measure of production performance, and to control for the impact of inflation (Ferrier & Lovell 1990; Schaffnit et al. 1997; Athanassopoulos & Giokas 2000; Camanho & Dyson 2005; Yang 2009). Therefore, two real indicators of bank production, namely number of advances (y_3) and number of deposits (y_4), are considered as outputs for Model 2, while number of employees (x_1), number of bank branches (x_2) and deprecation (x_3) are used as the inputs.[87] Measuring the efficiency of banks at the regional level by using two models of

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[87] The inputs used for Models 1 and 2 are the same. All the inputs and outputs in Model 2 are quantities, except for depreciation which is in real terms (constant prices). A mix of real and financial data is also used in the literature (Camanho & Dyson 2005; Camanho & Dyson 2008). The financial value of depreciation is used as a proxy for capital use of the banks at the regional level in the absence of real indicators.

inputs/outputs based on the volume and number of advances and deposits enables the assessment of bank performance from two standpoints (Giokas 2008; Yang 2009).

Model 1 measures the production efficiency of banks with respect to the volume of outputs (i.e. total monetary value of advances and deposits). The efficient generation of an appropriate volume of advances and deposits is important for expansion in the banking sector. Model 2 provides evidence of bank efficiency by assessing the number of advances and deposits. The ability to produce the maximum number of advances and deposits using a given input would be useful for increasing the customer base and spreading banking facilities among a large spectrum of the population in a region. The descriptive statistics of the inputs and outputs used in this study are presented in Table 6.1

An unbalanced dataset comprising regional aggregates of selected inputs and outputs for nine banks from 2011 to 2014 was used in this regional analysis.[88] Out of the 12 banks with sufficient regional coverage during this period, only nine banks are included in the dataset. Three government banks, namely the Peoples Bank, the Bank of Ceylon and the National Savings Bank were excluded mainly due to the unavailability of data for some variables at the regional level.[89] The remaining sample of nine banks comprised eight commercial banks and one specialised bank. Foreign banks were not included in the sample due to their limited presence at the regional level.

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[88] The reference period covered only four years mainly due to the limited availability of a regional level breakdown of banking data.

[89] These three state-owned banks account for a substantial share of the banking sector at the national level as well as at the regional level. They are not included in the analysis mainly due to the unavailability of regional level data and inconsistencies in the available regional breakdowns. However, the nine banks included in the sample also have reasonable coverage, having a presence in all nine regions. Further, regional level data is also not available for the other small banks with limited coverage.

The dataset was unbalanced, with data from the eight banks for the year 2014, nine banks for year 2013, six banks for year 2012 and five banks for year 2011. The dataset therefore consisted of 252 regional level bank observations, and all the financial data is in 2011 prices after adjusting for inflation. Table 6.2 presents the structure of the pooled data used in the regional analysis.

Table 6.1: Descriptive statistics of inputs and outputs used in measuring efficiency

Explanatory Variables	Units	Mean	Median	Standard Deviation	Min.	Max.
Model 1						
Inputs						
Number of bank branches (x_1)	Number	16	10	21	1	125
Number of employees (x_2)	Number	295	98	629	4	3,484
Depreciation (x_3)	Rupees Mn'	48.43	13.01	112.11	0.74	684.49
Outputs						
Total volume of advances (y_3)	Rupees Mn'	15,629	3,698	41,045	116	260,223
Total volume of deposits (y_4)	Rupees Mn'	17,290	3,446	44,326	100	280,518
Model 2						
Inputs						
Number of bank branches (x_1)	Number	16	10	21	1	125
Number of employees (x_2)	Number	295	98	629	4	3,484
Depreciation (x_3)	Rupees Mn'	48,425	13,011	112,113	735	684,494
Outputs						
Total number of advances (y_1)	Number	35,063	12,000	77,591	157	620,259
Total number of deposits (y_2)	Number	158,363	67,897	312,540	1,106	2,012,000

Source: Author's calculations

Table 6.2: Number of bank observations by region

Region	Year				Total
	2011	2012	2013	2014	

Western	5	6	9	8	28
Central	5	6	9	8	28
Southern	5	6	9	8	28
Northern	5	6	9	8	28
Eastern	5	6	9	8	28
North Western	5	6	9	8	28
North Central	5	6	9	8	28
Uva	5	6	9	8	28
Sabaragamuwa	5	6	9	8	28
All	45	54	81	72	252

6.2.2 Regional socio-economic diversity in Sri Lanka

The nine regions in Sri Lanka were demarcated during the pre-independence era mainly for the administrative convenience of the British rulers. Regional differences in socio-economic conditions across these regions are well documented in the literature, which also highlights the importance of inclusive economic growth in developing countries (WB 2009; UNDP 2012; Wijerathna et al. 2014). In the area of banking performance, socio-economic conditions are employed in this study to explain differences in the efficiency of banks, particularly across the regions (Miyakoshi & Tsukuda 2004; Bos & Kool 2006; Kenjegalieva et al. 2009; Battaglia et al. 2010). Therefore, in the context of Sri Lanka, it is important to review the socio-economic conditions of the nine regions prior to evaluating banking efficiency at the regional level. This is the case for two main reasons. First, reviewing the socio-economic conditions of the nine regions enables a comprehensive analysis of banking efficiency across the regions. Socio-economic conditions could be useful for explaining some of the efficiency differences and for highlighting possible linkages between banking efficiency and socio-economic conditions at the regional level. Second, it is essential to consider socio-economic

dimensions when deriving policy recommendations aimed at alleviating inequality in banking efficiency among these geographical regions in the country.

Historically, the Western region has been the richest of Sri Lanka's nine regions. The gap between the Western region and other regions in terms of some key indicators such as household income and population density was noticeable even in the 1950s. This gap has persisted and is reflected in the key socio-economic conditions presented in Table 6.3. The Western region has shown a higher level of economic prosperity than the other regions, recording the highest per capita GDP, the highest deposit density and the highest number of deposits per capita. The poverty rate is lowest in the Western region while the unemployment rate is also lower. This indicates a higher living standard in the Western region compared to the other regions. The lowest GDP and labour force share contributed by agriculture is also recorded in the Western region. The limited involvement in agriculture, which is less profitable than other sectors of the economy, has improved living standards and economic development in the Western region (CBSL 2012a; 2014). In addition, the highest population density is recorded in the Western region which has a relatively high level of urbanisation.

In terms of most socio-economic indicators, the Western region is followed by the Southern, North Western and Central regions. Sri Lanka's second- and third-largest cities are in the Central and Southern regions respectively. These three regions also recorded relatively high per capita GDPs, deposit densities, deposits per capita and population densities.

Table 6.3: Regional level socio-economic indicators for the period 2011–2014

Region	Per capita GDP (Rupees 000')	Agri. share in GDP	Labour force in Agri. (%)	Poverty head count index (%)	Unempl-oyment rate	Population density (per Sq. km)	Deposit density (LKR 000'per Sq. km)	Per capita Deposits (LKR 000')
Western	557	2.6	7.4	2.0	3.7	1,635	672,941	411
Central	296	13.7	40.8	6.6	4.8	465	36,908	79
Southern	333	13.8	36.7	7.7	5.4	464	36,730	79
Northern	257	18.1	32.5	10.9	5.2	129	15,221	118
Eastern	287	15.2	33.0	11.0	5.2	168	7,472	45
North Western	327	13.7	32.3	6.0	3.8	319	23,883	75
North Central	293	17.7	54.1	7.3	3.1	131	7,586	58
Uva	281	22.7	60.5	15.4	3.1	154	8,032	52
Sabaragamuwa	254	16.1	35.5	8.8	4.8	395	27,578	70

Note: The poverty headcount index is based on the household income and expenditure survey (HIES) conducted in 2012/13 by DCS Sri Lanka. Other indicators are derived from averaging annual numbers for the period 2011–2014.

Source: Author's calculations based on various publications of the CBSL and DCS Sri Lanka.

Further, their poverty headcount, share of GDP in agriculture and percentage of labour force in agriculture are also lower than in all other regions except the Western region. These regions also have household incomes higher than those of all regions except the Western region and have a larger share of the industry and services sectors in their GDP. These sectors are more productive than agriculture in Sri Lanka.

Most of the socio-economic conditions of the other five regions, namely Sabaragamuwa, North Central, Northern, Uav and Eastern are lower than those for the Western, Southern, North Western and Central regions. In each of these five regions, agriculture contributes more than 15% of their GDP. The Northern and Eastern regions are war torn and were badly affected by the 26-year armed conflict which ended in 2009. The two regions in which agriculture contributes the highest proportion of GDP are the Uva and North Central regions. In both these regions more than 50% of the labour force is involved in agriculture. The lowest unemployment rates are also in the Uva and North Central regions.[90] This low unemployment rate cannot be considered to be favourable since it could be due to the extensive involvement of the workforce in the low productivity agriculture sector. This is confirmed by the fact that the Uva region is the region with both the highest poverty rate and the lowest unemployment rate.

Among the banking-related indicators presented in Table 6.3 the highest deposit density was found in the Western region followed by the Central, Southern and North Western

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[90] Further, 13% of the population in the Uva region are Tamils of Indian origin who migrated to Sri Lanka as estate workers in the 18th and 19th centuries when the country was ruled by the British. Most of them work for relatively low salaries in the estate sector as unskilled labourers. Tamils in the estate sector are considered to be the poorest segment of Sri Lankan society. Their income level and other measures of living standard are much below the urban and rural sectors (DCS 2015). The rural sector of the Uva region lags behind the rural sector in other areas mainly due to a lack of irrigation systems and less rainfall for agriculture.

regions. This is in line with most of the other socio-economic indicators. It is worth noting that the conflict-affected Northern region was in fifth place with respect to deposit density. With respect to per capita deposits the Northern region was found to be the second-highest after the Western region.[91] The favourable banking indicators recorded for the Northern region could be due to two main reasons. First, people in the Northern region have a tendency to keep their money in bank deposits or gold due to the uncertainty of investments prevailing during the 26-year armed conflict. Second, a large number of relatives of the Tamil population live abroad and their remittances come through the banking system. The author's calculations based on micro data from the Consumer and Finances and Socioeconomic survey (CFS) conducted by the CBSL in 2003–2004 showed that 20% of the country's foreign remittances went to the Northern and Eastern regions, excluding the Killinochchi, Mannar and Mulaitive districts. Using data from CFS 2003/04 Sarvananthan (2007) has also highlighted the higher household level of remittances in the Northern region of Sri Lanka from overseas and other regions.

It seems that indicators based on regional level banking penetration are in line with other socio-economic indicators. This provides a primary indication of a relationship between banking performance and the socio-economic environment. Literature on the influence of socio-economic conditions on banking performance has been discussed in Chapter 3 in the review of the literature. Section 6.4.1 also highlights the relevant literature in this area.

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[91] Deposit density is not a good indicator of the distribution of household-level or individual-level deposits due to the different sizes of the regions. Therefore, per capita deposits by region are also used to review deposit density at the household or individual levels. Deposit densities and per capita deposits are calculated based on the deposits collected by commercial and specialised banks. In addition to the commercial and specialised banks, cooperative banks, rural banks affiliated to the Samurdhi authority, the government arm for empowering poor households, and small scale rural banks maintained by thrift societies are operated in the country. However they only account for less than 2% of total banking assets.

As highlighted in the literature, regional banking performance in Sri Lanka can also be influenced by regional level socio-economic conditions. Therefore, this study assesses the impact of selected socio-economic variables on bank efficiency at the regional level.

6.3 A comparison of banking efficiency across the regions

A regional level analysis of banking efficiency is vital for comprehensive policy formulation, as both policymakers and economists recognise that imperfections in the financial sector at the regional level could lead to economic disparities (Halkos & Tzeremes 2010; Burgstaller 2013). As mentioned in Chapter 2, banking services, along with most other economic activities, are concentrated in the richest Western region, and policy makers in Sri Lanka have introduced a number of regulations and reforms to improve banking sector penetration in other regions. Therefore, banking sector efficiencies are compared in this analysis across the nine regions in Sri Lanka. The efficiency of banks at the regional level was measured relative to a common frontier derived for all 252 regional level bank observations for the period 2011–2014.

In comparing regional level banking efficiency, this study uses Färe and Zelenyuk's weighted aggregate efficiency measures derived for each region. The weights used in compiling the aggregate efficiency scores are based on the output share of each bank in total regional banking output. The common statistic for comparing the efficiency of two groups of banks is the simple average which does not take account of variations in the sizes of the banks. This is because the measure of efficiency is a relative figure based on the frontier and it is not influenced by the size of the banks. In other words, as mentioned in Färe and Zelenyuk (2003), aggregate efficiency scores incorporate the structure of the banking sector within the region with respect to banking output, thereby enabling a

comparison of efficiency across the regions. Further, the RD statistic introduced by Simar and Zelenyuk (2007) is also employed to assess the statistical significance of differences in banking efficiency across regions. Although the overlapping of confidence intervals derived through bootstrap simulation is generally used to compare two groups of banks, relatively strong conclusions can be derived through a hypothesis test using a point estimate based on RD statistics.

Comparison of banking efficiency based on aggregate efficiency

The results of the two DEA-based production models used for the efficiency analysis are presented in Table 6.4. The name of the region, original aggregate efficiency estimates, bias-corrected aggregate efficiency estimates and rankings based on efficiency levels are provided for Model 1 and Model 2. As explained earlier, Model 1 uses the number of advances and deposits as the output while Model 2 uses volume of advances and deposits. Common inputs for both Model 1 and Model 2 are number of branches, number of staff and depreciation.

When the volume of advances and deposits is considered as the output of a bank's production, as in Model 1, the highest levels of efficiency are found in the Western, Central and North Western regions, while the Eastern, Uva and North Central regions recorded the poorest performances. The results for Model 2 suggest that three regions can be labelled as being the most efficient in Sri Lanka: Sabaragamuwa, Western and Central, whereas the Eastern, North Central and Uva regions were found to be the least efficient in producing advances and numbers of deposits with given inputs. It is worth noting that the Western and Central regions recorded higher efficiency in the production of advances

and deposits with respect to both number and volume. In line with the performance of the banks, these two regions account for the highest population density and lowest agriculture sector share in their regional economies.

Table 6.4: Regional level aggregate efficiencies for the period 2011–2014

Region	Model 1			Model 2		
	Bias Corr. Estimates	Original Estimates	Rank	Bias Corr. Estimates	Original Estimates	Rank
Western	1.279	1.202	1	1.310	1.249	2
Central	1.609	1.501	2	1.337	1.295	3
Southern	1.913	1.739	5	1.359	1.311	4
Northern	1.838	1.759	6	1.356	1.312	5
Eastern	3.081	2.775	9	1.760	1.656	9
North Western	1.657	1.504	3	1.370	1.315	6
North Central	2.482	2.185	7	1.592	1.482	8
Uva	2.656	2.347	8	1.400	1.335	7
Sabaragamuwa	1.780	1.620	4	1.282	1.232	1
All	1.457	1.352		1.372	1.296	

Source: Author's calculations

When the worst performances in the banking sector at the regional level are considered, the Eastern, North Central and Uva regions recorded the lowest efficiency levels in terms of advances and deposit production with respect to both number and volume. Geographically, these three regions are far away from the richest Western region. Their per capita GDP and population density are at a lower level while agriculture's share of the economy and the poverty head count rates are higher than they are in the other regions. It seems that the production efficiency of banks in terms of advances and deposits could be influenced by socio-economic factors such as the structure of the regional economy,

poverty and population density.[92]

Similar findings were observed when the sample of banks is restricted only to the commercial banks recording highest banking sector aggregate efficiency in Western region with respect to the Model 1 and lowest aggregate efficiency in Sabaragamuwa region with respect to the Model 2 (see Table F.4.1 in Appendix F).

Other than the ranking of the aggregate efficiency of banks across the regions, Table 6.4 provides a measure of the significance of differences in aggregate efficiency between the regions. The RD statistic introduced for comparison of two groups by Färe and Zelenyuk (2003) has been extended to cover nine groups for this analysis. The Western region, the richest region with the highest share in banking activities, is used as the benchmark in this comparison.[93] The banks' aggregate production efficiency of the eight non-western regions have been compared with the Western region. Comparing banking efficiency with the Western region is more appropriate than comparing it with national level aggregate efficiency for three main reasons.

First, policy directions are focused on achieving broad-based and inclusive growth by addressing the difference in banking performance between the Western and other regions. Sri Lankan policy makers use the Western region as a benchmark in formulating policies to push the other regions up to the level of the Western region. Second, higher efficiency

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[92] A multi-dimensional analysis to assess the impact of socio-economic factors on region level bank efficiency is presented in Section 6.4 of this chapter.

[93] The Western region accounts for the highest share of many aspects of banking activity including: banking density, deposit density and highest banking sector per capita value added. The policy strategies for achieving inclusive and broad-based economic development have mostly focused on minimising these disparities between the Western region and other regions.

was found in the Western region in the preliminary analysis of regional level banks (see Table 6.3). Third, the Western region is in a better position with respect to banking sector developments as well as overall economic development. The Western region has the highest bank penetration and its per capita income is 1.5 times that of the national figure. Therefore, it is important to compare the banking efficiency of the other regions against that of the Western region rather than taking the national average of efficiency as the benchmark.[94]

The RD statistic is derived by dividing the aggregate efficiency of a region's banks by the aggregate efficiency of the Western region's banks. RD statistics and the 95% confidence interval for the RD statistics for Model 1 and Model 2 are presented in Table 6.5. According to Table 6.5 the confidence intervals of the RD statistic based on Model 1 for all the regions, except that of the Northern region, do not include unity ('1'). Therefore, except for the Northern region, the aggregate efficiencies of all other regions are significantly lower than that of the Western region. These significantly lower efficiency levels with respect to the volume of advances and deposits could be due to lower demand and/or excess use of resources for the production of banking services.

The Western region, as the richest and most commercialised region, has a higher demand for larger bank deposits and advances. In general, banks in the Western region can maintain smaller administration costs because they handle larger deposits and advances than banks in other regions. On the other hand, banks located in rural regions have higher

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[94] Although a paired comparison of bank efficiency among the nine regions is also possible with aggregate efficiency by Färe and Zelenyuk (2003) and Simar and Zelenyuk (2007), it is difficult to derive policy recommendation based on complex results of 72 paired comparisons.

administration costs due to the small size of deposits and advances. In addition, the efficiency of banks in other regions can be affected by the lower demand for banking services due to lower levels of economic activity. However, the Northern region does not show a significant deviation from the bank efficiency levels of the Western region. This could be due to heavy deposit mobilisation in the Northern region with their different banking practices linked to social aspects as explained in Section 6.2.2.

The RD statistic for Model 2 indicates that the aggregate efficiencies for all of the regions are not significantly different from those of the Western region, since all the confidence intervals of the RD statistics include unity. The results reveal an absence of significant deviations of the efficiency level of the banks in other regions from those of the Western region with respect to the production of number of advances and deposits. Although the non-Western regions produce or maintain deposits and advances, the average sizes of those advances are small. This could be due to the lower socio-economic conditions prevailing in those regions. Similarly, large scale disbursement of small advances by government-subsidised loan schemes can also increase the number of advances in rural banks. The higher number of deposits and advances in rural areas could increase the administrative costs of the banks, although the efficiencies of the banks in terms of the numbers of advances and deposits in rural areas are not significantly different from those in the Western region. This is indicated by the significantly lower efficiency prevailing with respect to the volumes of deposits and advances (Model 1), while similar efficiency levels are found with respect to the number of deposits and advances relative to the Western region (Model 2).

An analysis of aggregate efficiency at the regional level shows differences in the production performance of banks when the outputs are measured in terms of both number and volume of deposits and advances. A further comparison of production efficiency, particularly based on RD statistics, confirmed the significantly lower efficiency levels in most of the regions relative to the Western region relating to output as measured by volume of advances and deposits. The differences in efficiency across regions are more pervasive at the individual bank level rather than at the regional level. The superior performance of banking sector production efficiency in Western region in terms of producing volume of advances and deposits is also observed when the analysis is focused only on commercial banks (see Table F.4.2 in Appendix F).

These differences in efficiency in producing advances and deposits could be due to many factors including regional level environmental factors. Therefore, the next section of this chapter evaluates the impact of socio-economic factors on bank efficiency based on double-bootstrap regression models.

Table 6.5: Comparison of aggregate regional banking efficiency based on the period 2011–2014.

Regional comparison	Model 1			Model 2		
	Bias Corr. RD Estimates	95% CI bounds		Bias Corr. RD Estimates	95% CI bounds	
		LB	UB		LB	UB
Central vs Western	1.257***	0.975	1.466	1.012	0.674	1.268
Southern vs Western	1.500***	1.247	1.730	1.028	0.666	1.278
Northern vs Western	1.430	0.566	1.859	1.026	0.584	1.289
Eastern vs Western	2.419***	1.697	2.970	1.336	0.828	1.676
North Western vs Western	1.299**	1.068	1.492	1.038	0.747	1.269
North Central vs Western	1.955***	1.494	2.337	1.211	0.823	1.494
Uva vs Western	2.090***	1.596	2.478	1.061	0.715	1.308
Sabaragamuwa vs Western	1.395*	0.962	1.675	0.971	0.696	1.179

Note: The coefficients with ***, ** and * indicate statistical significance from zero at the 1%, 5% and 10% levels, respectively; CI is confidence interval; LB is lower bound; UB is upper bound.

Source: Author's calculations

6.4 Impact of regional level environmental variables on banking efficiency

The previous section assessed differences in the production performances of banks at the regional level using weighted aggregate efficiency measures corrected for bias. The literature highlights a number of regional level factors which can be instrumental in creating differences in bank performance across regions. Therefore, this section assesses the impact of selected regional level socio-economic variables on banking sector production performance by using a double-bootstrap truncated regression model. It is worth noting that the impact of socio-economic variables on individual bank level efficiency scores at the regional level is evaluated in this analysis. As in the previous section, regional level data belonging to the period from 2011 to 2014 is pooled, assuming that there have been no technological changes during this period which could influence the performance of banks. Therefore, the efficiency of banks at the regional level is compared against the efficient frontier based on pooled bank observations for this reference period.

6.4.1 Specifications of regional level environmental variables

The selection of regional level environmental variables used in this study is mainly based on previous empirical studies, regional differences in the context of Sri Lanka and the availability of data. As discussed in the literature review in Chapter 3, the environmental variables incorporated into this analysis can be categorised into three groups, namely macroeconomic variables, socio-demographic variables and other variables. Regional GDP per capita and regional level unemployment rates are included as macroeconomic variables. Regional level socio-demographic variables included in the analysis are population density, deposit density and education level of the region. A dummy variable capturing other regional differences in banking efficiency is also included in the model.[95] In addition, dummy variables for possible differences in efficiency across commercial and specialised banks and years of the study to capture trends over time are also included in the regression analysis. A description of the environmental variables used in this analysis is given below.

Regional GDP per capita

The relationship between economic growth and quality of the financial sector is well established in the literature (Pagano 1993). Although an improvement in bank production performance can be expected in a more conducive macroeconomic environment, banking efficiency studies provide mixed results relating to the impact of bank efficiency on regional economic growth (Miyakoshi & Tsukuda 2004; Bos & Kool 2006; Glass &

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[95] The poverty headcount index is also used as an indicator of socio-demographic changes in the literature, especially studies related to rural banking (Ravallion & Wodon 2000; Zhuang et al. 2009; Jeanneney & Kpodar 2011). However, poverty is not included in the analysis due to the strong empirical evidence for unidirectional causality of financial sector developments on poverty (Menon & Van der Meulen Rodgers 2011).

McKillop 2006; Kenjegalieva et al. 2009; Battaglia et al. 2010). The impact of regional economic growth on banking performance can change depending on the macroeconomic and socio-demographic environments in the region or country. In Sri Lanka significant variations can also be observed in regional GDP per capita. Hence it is important to study the relationship between the economic environment and banking sector performance at the regional level in order to formulate effective policies to develop the financial sector. Regional level annual GDP per capita for the nine regions in Sri Lanka is used in this study as a proxy for the level of economic development.[96]

Population density

Population density has also been identified in the literature as a factor influencing banking sector performance, since banking services are dependent on the demand from the population of an area (Lozano-Vivas et al. 2002). The cost of distributing banking services will be lower with higher levels of population density and it could therefore improve the efficiency of banks. When population density is low in a region, the efficiency of banks operating in it can be low if demand for banking services is limited and banks are not able to generate enough output. In a region with low population density, banks could have a large number of branches to cover a larger geographical area.[97] This larger branch network could also lead to higher structural overheads which negatively influence efficiency (Maudos et al. 2002b). Therefore, population density is included in

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[96] In compiling the regional GDP of Sri Lanka, the CBSL disaggregated national GDP numbers in current prices to the regions based on a large number of economic indicators related to each economic sector. Regional level GDP in constant prices was not available mainly due to a lack of regional level reliable price indexes in Sri Lanka (Muthaliph et al. 2002; Muthaliph 2005). Hence, the national level CPI is used to derive the per capita regional level GDP at 2011 based constant prices in this study.

[97] Sri Lankan banks are directed to open another two branches in a regional area when they want to open a branch in the Western region, and a bank may also open branches in rural areas with the long-term objective of improving market share.

some studies of banking performance at the regional and national levels (Evanoff 1988; Dietsch & Lozano-Vivas 2000; Lozano-Vivas et al. 2002).

Significant disparities in population density can also be seen in Sri Lanka across the regions. Table 6.3 shows that population density in Western and surrounding regions is high while population density in regions located away from the Western region is low. As in most studies in the literature, this study used the annual average number of people living in a square kilometre as a measure of population density. This data is based on the annual population estimates published by the DCS of Sri Lanka.[98]

Deposit density

Deposit density is assumed to be a relevant proxy of the demand for banking services in determining banking efficiency (Dietsch & Lozano-Vivas 2000; Fries & Taci 2005; Hermes & Nhung 2010). A lower density of demand could impose a constraint on the level of efficiency attainable by banks due to low demand for banking services while experiencing overhead expenses similar to those of other banks, ceteris paribus, in more densely populated regions (Dietsch & Lozano-Vivas 2000; Lozano-Vivas et al. 2001; Lozano-Vivas et al. 2002). In an environment of low density of demand for banking services, banks could suffer from high costs in making advances and mobilising deposits. Banks operating in regional areas can be in a disadvantageous position due to the negative impacts arising from higher per unit costs due to lower production volumes. Density of demand for banking services is usually proxied by the density of deposits as measured by the ratio of total value of deposits per square kilometre of land (Fries & Taci 2005).

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[98] The annual population numbers estimated by the Department of Census and Statistics Sri Lanka are based on the population census conducted in 2012 and annual death and birth records.

It is expected that there is a positive relationship between density of demand and banking efficiency (Dietsch & Lozano-Vivas 2000; Lozano-Vivas et al. 2002). However, a negative or insignificant relationship between density of demand and banking efficiency has been found by some studies as against the expected positive result predicted by economic theory (Fries & Taci 2005; Hermes & Nhung 2010). Deposit density of the banks also varied across the regions. Accordingly this study has employed density of deposits for each region to capture the impact of density of demand for banking services on banking efficiency at the regional level.[99]

Unemployment

The literature has also highlighted the potential influence of the unemployment level on banking efficiency at the regional or national levels (Glass & McKillop 2006; Kenjegalieva et al. 2009). Mixed results can be observed from studies assessing the relatisonship between unemployment and the performance of banks. A majority of studies have found a negative impact of unemployment on banking sector performance. According to these studies a reduction in bank funding sources, due to a decline in savings and demand for credit consequent upon higher unemployment, can dampen the performance of banks (Önder & Özyıldırım 2010; Liu et al. 2013a). Changes in the unemployment rate have also been identified as a key factor influencing the stability of the banking system (Liu et al. 2013a). In addition to indicators such as GDP per capita,

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[99] Only the commercial banks and specialised banks are considered in this study in calculating the deposit density for Sri Lanka. These commercial banks and specialised banks account for 98% of total banking sector assets, excluding assets owned by the CBSL (CBSL 2014). The regional level deposits of the Hatton National Bank for 2012 are estimated by using the trend from earlier years and annual data for 2012 due to the unavailability of a regional breakdown of its deposits.

the unemployment rate is also a potentially useful indicator of the regional production level. As presented in Table 6.3, unemployment rates vary significantly across the regions. Therefore, inclusion of the umeployment rate as a potential regional determiant of banking effciency can be justified. Regional annual unemployment rates were extracted from the annual labour force survey conducted by the DCS of Sri Lanka for the reference period.

Education level

The level of knowledge of the population has also been identified in the banking literature as a factor influencing access to finance (Ravallion & Wodon 2000). It has been empirically shown that the understanding about the banking product is dependent on the knowledge of the bank customer (Wheatley 2010; Pyle et al. 2012). Studies in banking performance, particularly at the regional level, have also incorporated the education level of the region as a possible determinant of the performance of banks operating in that region (Valverde & Fernández 2004). Among the numerous indicators of educational attainment, the percentage of the population with tertiary education and post-secondary education are commonly used in regional banking and finance studies (Devlin 2005; Simpson & Buckland 2009). In the context of Sri Lanka, heterogeneity in the education level of the population can also be observed across the regions. Accordingly, this study has used the percentage of the population with secondary education as a proxy variable for the educational attainment of the population in particular regions.[100] The data on

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[100] Secondary education is defined as completion of the government certificate in education (GCE) ordinary level (OL) examination after more than 10 years of schooling.

education levels of the regions were extracted from the household income and expenditure survey conducted by the DCS of Sri Lanka in 2012.[101]

Type of bank

Data from two types of banks, namely commercial and specialised banks, are used in this regional level analysis of banking sector production efficiency.[102] There are differences in the banking services provided by these two types of banks. Specialised banks are mostly focused on deposit collection and disbursement of small advances to households and the SME sector and they are not allowed to open current accounts for their customers.[103] Commercial banks provide banking services to all segments of society. Therefore, a dummy variable is included in the models to capture possible difference in banking efficiency between the two groups.

Regional differences

In addition to the impact of the above socio-economic differences which have been incorporated into the analysis, there are other regional level factors which can influence banking performance. Therefore, a dummy variable is included in the model to capture any other unobservable differences in banking efficiency across the nine regions in Sri Lanka. This dummy variable has nine levels representing the nine regions in Sri Lanka.

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[101] Annual data is not available since socio-demographic data is mostly collected in household level surveys. On the other hand, significant changes cannot be observed in the level of the education in the regional population within the reference period of the study from 2011 to 2014.

[102] All the banks used in the analysis are domestic private banks and, therefore, the impact of type of ownership such as state-owned vs. private or domestic vs. foreign cannot be tested.

[103] Customers of specialised banks cannot issue cheques against their bank balances.

Time trend

A variable is also included in the model to capture the impact of time varying factors on the production efficiency of the banking sector at the regional level due to the evolving nature of efficiency.

6.4.2   Descriptive statistics of the environmental variables

Table 6.5 provides a summary of the descriptive statistics relating to the environmental variables used in the analysis. Per capita regional GDP and deposit density are expressed in 2011 prices after adjusting for inflation. Deposit density is derived by dividing total deposits owned by both the commercial and specialised banks in each region by the land area in square kilometres. Similarly, population density is derived by dividing the total population in a region by land area in square kilometres. The regional level annual unemployment rate and national level annual inflation rate are used and these are expressed as percentages. Further, descriptive statistics of the three dummy variables used to control for any unobservable impact based on bank type, region and time trend are also presented in Table 6.6. The natural logarithms of regional level annual data for per capita GDP, population density and deposit density are used in the regression analysis.[104] Expected relationships between selected socio-economic variables and regional banking efficiency are also summarised in Table 6.7.[105]

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[104] Natural logarithm transformations are commonly used in the literature to avoid large coefficients in models particularly with respect to large values.

[105] The expected relationships are based upon the literature discussed previously. However, these are general expectations and the expected relationship can also be dependent on country, region and influence of other factors.

Table 6.6: Descriptive statistics of the environmental variables

Variable	Description	Mean	Standard Deviation	Minimum	Maximum
GDPP	Regional per capita GDP	328.9	96.7	202.0	612.9
DENSI	Average number of people living in a square kilometre in the region	429.4	447.9	128.0	1,652.0
DDEN	Total value of deposits per square kilometre in the region	95,262.9	13,523.2	6,540.5	844,940.7
UNEMP	Regional level unemployment rate	4.3	1.0	2.5	6.8
EDU	Percentage of population with secondary level education in the region	24.9	5.3	18.5	37.9
BTYPE	Type of bank (1- commercial 0-specialised)	0.9	0.3	0.0	1.0
REG	Dummy variable for 9 regions (0 to 8)	5.0	2.6	1.0	9.0
Time	Dummy variable for 4 years (0 to 3)	1.7	1.1	0.0	3.0

Note: Regional level per capita income (GDPP) and deposit density (DDEN) are in Sri Lankan rupees (thousands). The unemployment rate (UNEMP) and inflation rate (INFL) are in percentages.

Source: Author's calculations

Table 6.7: Expected relationships between selected socio-economic variables and inefficiency

Socio-economic variable	Expected relationship
Regional GDP	Negative
Population density	Negative
Deposit density	Negative
Unemployment	Positive
Education level	Negative

Note: The dependent variable is the technical inefficiencies (Farrell's efficiency scores) recorded by the bank at the regional level. A negative relationship between a socio-economic variable and the dependent variable suggests the socio-economic variable improves efficiency. On the other hand a positive relationship suggests that the socio-economic variable reduce efficiency.

Source: Author's classification

6.4.3   Regional determinants of banking efficiency

In this section, efficiency scores have been used as the dependent variable to find the regional determinants of banking efficiency using two regression models. The first regression Model 1(V) uses the efficiency scores derived when output is measured in monetary volume (i.e. output in Sri Lankan rupees) of advances and deposits as the dependent variable. In this model, V stands for the volume of advances and deposits used

in deriving efficiency scores. The second regression Model 2(N) uses efficiency scores derived when output is measured in number of advances and deposits as the dependent variable. In this Model, N stands for the number of advances and deposits used in deriving efficiency scores. The impact of the same set of variables on bank efficiency is tested by both Model 1(V) and Model 2(N). Table 6.8 provides the coefficients of the environmental variables and their level of significance in the models.

As discussed earlier, Farrell's efficiency scores presented in this study are higher than unity when a bank is relatively inefficient. Thus, positive values for coefficients in both Model 1(V) and Model 2(N) indicate positive influences on inefficiency or negative influences on efficiency. Similarly, a negative sign for a coefficient indicates a negative influence on inefficiency or a positive influence on efficiency. In the interpretation of the results from the following models the influence on efficiency is explained rather than explaining inefficiency.

According to the results presented in Table 6.8 there is a negative relationship between bank performance and regional GDP per capita when efficiency is measured based on the volume of advances and deposits in Model 1(V). This influence of regional GDP per capita on banks' performance with respect to the production of volume of advances and deposits, however, is not significant. However, there is a significant and positive influence of regional GDP per capita on the performance of banks with respect to efficiency in producing number of advances and deposits based on Model 2(N).

Table 6.8: Determinants of regional level banking efficiency based on double-bootstrap regression models.

Variable	Model 1(V)			Model 2(N)		
	Estimates	95% CI bounds		Estimates	95% CI bounds	
		LB	UB		LB	UB
Constant	19.589	-11.285	51.23	-2.972**	-4.461	-0.779
GDPPL	0.587	-4.676	5.656	-1.756***	-2.403	-1.238
DENSIL	-2.353**	-4.056	-0.535	0.255**	0.031	0.385
DDENL	-1.368	-3.767	1.143	-2.188***	-2.573	-1.889
UNEMP	0.422	-0.201	1.081	1.052***	0.589	1.692
EDU	0.268	-0.247	0.805	0.150**	0.041	0.233
BTYPE	-4.156***	-5.476	-2.82	14.613***	12.67	16.866
REG	-0.023	-0.297	0.262	-0.046	-0.246	0.137
TIME	-0.055	-0.897	0.686	0.663***	0.507	0.837

Note: (1) The coefficients with *** and ** indicate statistical significance from zero at the 1% and 5% levels, respectively. GDPPL is the logarithm of regional per capita GDP; DENSIL is the logarithm of population density; DDENL is the logarithm of deposit density; UNEMP is the regional level unemployment rate; EDU is the percentage of the population with secondary level education in the region; BTYPE is a dummy variable for commercial and specialised banks; REG is a dummy variable for nine regions; TIME is a dummy variable for time trend; (2) The estimated confidence intervals are provided in Tables E.1 and E.2 in Appendix E.

Source: Author's calculations

These findings suggest that banks in richer regions with high per capita incomes are more efficient in terms of the number of advances and deposits produced. On the other hand, banks are less efficient in providing banking services in poor regions in terms of number of advances and deposits. This can be due to the higher demand for banking services in richer regions where there are more economic activities. The findings suggest that bank performance is not influenced by regional per capita income when output is measured in monetary volumes. Some empirical studies also find a negative relationship between regional per capita income and banking performance, particularly with respect to cost and production efficiencies (Glass & McKillop 2006; Kenjegalieva et al. 2009).

As expected the findings reveal a positive and significant relationship between regional level banking performance and population density across the regions when output is measured in monetary terms. This indicates that bank efficiency as measured with respect to the size of advances and deposits could improve with higher population density. A positive relationship between banking performance and population density is explained in the literature as being due to the costs involved in maintaining a higher number of branches to cover a large geographical area with low population density (Lozano-Vivas et al. 2002; Maudos et al. 2002b).

In line with the literature, Sri Lankan banks can have higher overhead expenditure relative to business volumes in regions with lower population densities such as the North Central and conflict-affected Northern regions. Setting up and maintaining a bank branch covering these areas can be costly due to the unavailability of the required infrastructure and distance from the head office. Higher population density negatively influences bank efficiency when output is measured in terms of the number of advances and deposits. This indicates that banking sector efficiency in terms of the number of advances and deposits is not improved with high population density. The Western region and its surrounding regions were found to be more economically developed with higher population densities than the other less economically advanced regions. In these less developed regions, the government provides subsidies and concessional loans particularly in the agriculture sector. Farmers used to open bank accounts in these poor regions to get those government subsidies. This can be one reason for a negative relationship between banking efficiency and population density when output is measured by the number of advances and deposits.

The findings reveal that deposit density, used as a proxy for demand for banking services, positively influences banking sector performance when output is measured in terms of volume of advances and deposits. However, this relationship is not significant. On the other hand, a significant positive influence of deposit density on banks' performance is found when the banks' outputs are measured in terms of number of advances and deposits. Hence the empirical results suggest that greater efficiency occurs in generating advances and deposits in an environment of higher deposit density. In general, higher deposit density is recorded in the richer regions. This positive relationship between deposit density and bank performance could be due to the higher demand for banking products emanating from richer regions. A positive relationship between efficiency and deposit density, when the volume of advances and deposits is taken as the output, is supported by previous studies (Dietsch & Lozano-Vivas 2000; Lozano-Vivas et al. 2002). However, this relationship is not found to be significant. The weak relationship between efficiency (in generating volume of advances/deposits) and density of deposits could be due to lower demand, particularly for advances in rural and conflict-affected areas. The highest advances to deposits ratio is found in the Western region and the lowest advances to deposits ratio is reported in the conflict-affected Northern region (Table 6.3).

According to Table 6.8 the unemployment rate has a negative relationship with the production performance of the banking sector at the regional level. The relationship is significant when the output of the banks is measured in terms of the number of advances and deposits. This negative relationship is in line with most previous studies (Önder & Özyıldırım 2010; Liu et al. 2013a). The production differences across the regions and income flows into households are reflected by the unemployment rate. Therefore, banking

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performance can be impacted by changes in the unemployment rate which can influence the availability of funds within the region.

A negative relationship was found between education level and bank efficiency. This relationship is significant only when the outputs of banks are measured in terms of the number of advances and deposits. Therefore, higher efficiency in producing number of advances and deposits can be expected in regions with a lower proportion of educated people. A possible explanation for this negative relationship is large scale bank account opening in less developed regions which recorded a relatively lower level of education attainment of the population. A summary of the major findings is provided in Table 6.9.

Table 6.9: Major empirical results and findings

Empirical Results	Major Findings
1) Bank aggregate efficiency of the Western region is significantly higher than it is in the other regions when output is measured in terms of volume of deposits and advances.	The banking industry in the Western region is more efficient than that in other regions with respect to the generation of volume of deposits and advances. An improvement in the efficiency of the banking industry in other regions, by increasing the generation of volume of deposits and advances, would be useful for these regions as well as the banking industry as a whole.
2) Bank aggregate efficiency of the Western region is not significantly higher than that in other regions when output is measured in terms of number of deposits and advances.	The performance of the banking industry in the Western region is not significantly different from that of the other regions with respect to the generation of number of deposits and advances. Optimum use of resources for the generation of deposits and advances is good for the banking industry and the regions. This shows that there is an efficient use of resources by the banking industry in all regions in generating number of advances and deposits.

Empirical Results	Major Findings
3) A positive significant influence of population density on bank efficiency is found when output is measured in terms of volume of deposits and advances.	A higher population density improves the efficiency of banks in generating deposits and advances. This is shown by the higher bank efficiency recorded in the Western region which is the most highly populated and urbanised region in Sri Lanka.
4) All five socio-economic variables, namely per capita GDP, population density, deposit density, unemployment rate and education level significantly influence the efficiency of banks when output is measured in terms of number of deposits and advances. The influence of GDP per capita and deposit density are positive while population density, unemployment rate and education level negatively influence efficiency.	The results show a higher influence of socio-economic factors on bank efficiency in generating number of deposits and advances. It seems that banks can expect higher efficiency in generating number of deposits and advances in developed areas with higher demand for banking activities. Population density has a negative impact on efficiency in terms of generating number of deposits and advances. This shows low efficiency in generating number of deposits and advances when the number of people living per square kilometre increases. This could be due to the large number of account openings in less developed regions due to government efforts in improving access to finance. The negative influence of the unemployment rate on bank efficiency in generating number of deposits and advances is in line with the majority of the literature due to the possible direct link with unemployment and circulation of money in the region.

Relationships between environmental variables and the regional level efficiency are also found when the study is focused only on commercial banks which own larger branch network at regional level relative to the specialised banks. Significant positive relationship between deposit density and efficiency is found with respect to the production of volume of deposits and loans among commercial banks indicating better commercial banking performance in regions with higher deposit density (see Table F.4.3 in Appendix F).

Robustness check

The technical inefficiency effects model based on SFA introduced by Battese and Coeli (1995) (BC model) is now used to assess the robustness of the results given by the double-bootstrap regression model. This parametric model only permits one output. Therefore, two outputs used in each model (Model 1(V) and Model 2(N)) are added to generalise the output for the BC model. Specifically, the production volume of the banks has been equated to the sum of advances and deposit volumes while production quantity has been equated to the sum of the number of advances and deposits. The findings of the BC model are in line with the findings of the double-bootstrap regression model, and highlight the significant impact of population density on the efficiency of bank output with respect to the monetary volumes. Further, the BC model also confirms the significant impact of a number of socio-economic factors on bank efficiency when output is measured in terms of the number of advances and deposits. All the socio-economic factors that are found to be significant in the double-bootstrap regression model are also significant in the BC models except for unemployment and the education level. The coefficients and their significance levels in the BC model are given in Table E.3 in Appendix E.

6.5 Summary

Introducing a new way of comparing the performance of banks across regions, this chapter has extended the established literature to evaluate banking efficiency by region in Sri Lanka during the post-conflict era. Weighted aggregate efficiency measures and double-bootstrap regression models are employed in order to provide comprehensive and informative efficiency measures aimed at explaining regional differences in banking

performance. The analysis assessed banking performance with respect to efficiency in the generation of number of advances and deposits as well as the monetary value of advances and deposits. The empirical findings of this study are pertinent for future policy decisions by the CBSL and policy makers as they provide a better evaluation of regional banking efficiency and of the determinants of banking efficiency during the post-conflict era. The study also explores regional disparities in banking efficiency in a developing country and provides a baseline for future research on regional level banking efficiency.

The findings highlight the superior performance of banks in the Western region compared to that of other regions when the output of banks is taken to be the volume of advances and deposits. These findings provide evidence of relative inefficiency in the production of volumes of advances and deposits by regions other than the Western region. It seems that the Western region has produced more advances and deposits from given inputs than the other regions have. This could be due to the greater demand for banking services in the Western region. The size of the advances and deposits could also be higher, in line with the other favourable socio-economic conditions, such as higher GDP per capita, population density and a lower unemployment rate, prevailing in the Western region. If the demand for banking services is relatively low in other regions, policy makers should provide the necessary directions/incentives to improve bank resource allocation in those areas in order to enhance production efficiency and encourage them to implement new cost-effective banking products that are more suited to regional areas such as mobile bank branches. Under these circumstances imposing regulations to ensure the expansion of banks' operations in regions other than that of the Western region, could decrease the production efficiency of banks in those regions and the banking sector as a whole. As an alternative, the establishment of cost-effective banking outlets in post-offices or

cooperative societies may be a way of improving the production efficiency of the banks while increasing the availability of the banking services in regional areas.

However, significant differences were not observed in banks' efficiency in the production of advances and deposits in terms of numbers. This shows that the number of advances and deposits produced as against the given input by banks in each region is not significantly different. This healthy disbursement of advances and mobilisation of deposits in regional areas is important for socio-economic development in those regions. The significantly higher production efficiency recorded by the Western region in terms of the volume of outputs (advances and deposits) could be due to large scale advances and deposits handled by the banks in the Western region. In general, the administrative costs of accepting deposits and disbursing advances are not dependent on the volume of transactions. Hence, a further reduction in the administrative costs of handling advances and deposits could improve bank efficiency at the regional level with respect to the volume of advances and deposits. The difference in production efficiency between the Western region and other regions with respect to the number of outputs (number of advances and deposits) are not significant.

Regression analysis has provided evidence of a significant impact of deposit density on the efficiency of banks at the regional level with respect to the volume of advances and deposits. When efficiency is measured based on the number of advances and deposits, all the socio-economic factors considered for the analysis indicate a significant influence on the efficiency of banks at the regional level. Hence, the empirical analysis revealed that at the regional level the efficiency of the banks in generating *number* of advances and

deposits is more sensitive to environmental variables than the efficiency of the banks in generating *volume* of advances and deposits with respect to the monetary value.

Overall, the analysis has highlighted differences in the production efficiency of banks in Sri Lanka at the regional level and differences in how socio-economic factors influence their efficiency. It is important to improve the performance of banks with respect to the number and volume of advances and deposits and reduce differences in the performance level particularly between the rich Western region and other regions. It is also worth noting that the Western region has recorded the highest production efficiency despite having the highest bank branch penetration. This could be partially due to the restriction imposed in recent years on branch expansion in the region. Therefore, Sri Lankan policy makers should encourage the geographical expansion of branch networks with caution, since network expansion could lead to a widening of the disparities in banking performance between the Western region and other regions. In the formulation of policies to improve the performance of banks at the regional level and to expand the geographical dispersion of banks, addressing the impact of socio-economic factors on production efficiency is also vital. The policy directions and recommendations derived from this regional analysis are presented in the next chapter.

Chapter 7   Policy implications and recommendations

7.1   Introduction

In general, policy makers and economists highlight the importance of financial sector development for the economic growth of a country (King & Levine 1993; Khan & Senhadji 2000; Beck & Levine 2004). Financial sector reforms are a commonly accepted and widely used strategy for promoting financial sector development. The   Sri Lankan government has continued to introduce financial sector reforms since 1977 when the country adopted open market economic policies. During the reference period of this study from 2006 to 2014, an array of reforms were introduced to the financial sector in the form of amendments to existing acts, CBSL directions and new regulations targeting its expansion, stability, efficiency and productivity. However, policy makers have been more concerned about introducing reforms into the financial sector in response to new challenges in the post-conflict era.

The results presented in this study shed light on new policy directions with the objective of achieving higher efficiency and productivity of the banking sector in Sri Lanka. The policy directions and recommendations presented in this chapter are based on these efficiency and productivity results for the period before and after the end of the conflict, differences in efficiency between bank groups, determinants of banking efficiency for the period 2006–2014 and regional level differences in banking efficiency and their determinants for the period 2011–2014.

The remainder of this chapter explores these policy issues in more detail and has the following structure. The background to the policy recommendations provided by the

empirical analysis is discussed in Section 7.2. Section 7.3 provides policy suggestions for institutional reforms. Recommendations for establishing a competitive banking market environment are presented in Section 7.4. Policies aimed at strengthening the regulatory and prudential framework of banks are discussed in Section 7.5. Policy changes needed at the regional level to achieve broad-based economic development and efficiency in the banking sector are explored in Section 7.6, followed by a summary of the chapter in Section 7.7.

7.2 Background for policy recommendations

It is important to review the findings from this study in order to provide the platform upon which the policy recommendations presented in this chapter are based. Therefore, the importance of number of empirical findings with respect to the policy formulations is discussed below.

(1) This study compared the efficiency of the banking sector in the post-conflict period with the period before the end of the armed conflict in 2009. It found that efficiency had improved and identified key factors contributing to this, against a background of supportive reforms and macroeconomic conditions prevailing during the post-conflict era. A gap in the technology sets used by banks between these two periods was found, confirming an improvement in the technology set used by the banking industry in the post-conflict period. An improvement in bank efficiency was also found in this study in an environment of expansion in geographical dispersion and branch networking. While one may highlight this as a salutary outcome of policy directions and a conducive economic environment, the challenge that remains is to formulate the necessary polices

that will maintain a higher banking efficiency level in the future, which will be of benefit to attaining the government's objectives of broad-based and inclusive growth.

(2) In a comparison of banking performance across the three different bank groups, the study found that domestic banks achieved a higher efficiency level than their foreign counterparts and specialised banks. This was particularly the case according to the analysis using the intermediation approach, despite the fact that local banks underwent large-scale branch expansion, while the outreach of foreign banks remained quite limited. While profit making through the provision of intermediation services to   Sri Lankan customers may not be at the top of the business agenda of foreign banks, positive spill-over effects, such as new technologies and products can be expected from the operations of foreign banks in the country. On the other hand, and as might be expected, foreign banks showed greater efficiency in profit-oriented operations. Less involvement in providing intermediation services and a strong focus on fee-based income are likely to have contributed to this higher performance of foreign banks in their profit-oriented operations. Confirming the superior technology performance of foreign banks, a view dominant in the mainstream banking literature, the meta-technology ratios of foreign commercial banks indicate that a superior technology set is used by them in providing intermediation services. This difference in technology sets between domestic and foreign commercial banks is also prominent with respect to the operational approach. Consequently, banking polices should focus on enhancing foreign bank participation in the banking industry in order to encourage domestic banks to take up improved technology and to minimise any obstacles facing domestic banks in attaining better technology.

(3) Significantly higher performance in domestic commercial banks than domestic specialised bank groups were recorded with respect to the average levels of efficiency in their intermediation activities. This reflects that on average the performances of some of the specialised banks were lower than those of domestic commercial banks with respect to intermediation. The efficiency of the specialised banks with respect to intermediation, however, is important for policy makers since most of these banks focus on SME lending, development lending and household sector lending. Their lower intermediation efficiency could result in an inefficient flow of funds to the SME sector, but there appears to be room for improvement in this area. The lower level of intermediation efficiency of some specialised banks could be an outcome of some negative influences, such as restrictions on their scope of banking services, high government involvement in some banks and low levels of IT usage. Hence, policy makers should explore the potential for further improvements in the efficiency of these specialised banks by addressing existing restrictions.

(4) Among the domestic commercial banks significantly higher intermediation efficiency was recorded by the two state-owned banks, reflecting the favoured position they hold in the banking sector. Further, the operational efficiency of state-owned commercial banks is at a similar level to that of private commercial banks. This provides evidence that the state-owned banks have efficient profit-oriented operations and they also provide essential intermediation services. Limited government involvement in the operations of state-owned banks in an open market environment in Sri Lanka, as well as their technological improvement, are underpinning factors for this performance.

(5) An analysis of the determinants of banking efficiency at the national level provides a holistic picture of the direction and intensity of the relationship between banking efficiency and environmental factors. The findings from this study suggest that branch expansion can be an effective policy tool which could achieve broad-based and inclusive growth by improving the geographical dispersion of branch networks. Importantly, the study results indicate the absence of a negative relationship between geographical dispersion, growth in branch networks and banking efficiency. This indicates the possibility of using banking expansion to target both economic and social cohesion. Adherence of the banking sector to capital requirements as outlined in the Basel directives should also be encouraged with caution, as this study has indicated a negative relationship between profit-oriented operational efficiency and the capital ratio for the commercial bank group.

(6) A comparison of banking efficiency at the regional level based on the production approach provides important insight into disparities in banking sector production performance across the nine regions of Sri Lanka. Further analysis revealed the impact of selected socio-economic factors on the production efficiency of the banks at the regional level. The production efficiency of banks at the regional level was measured with respect to output in terms of quantity (i.e. number of advances and deposits) and monetary volume (i.e. total value of advances and deposits in rupees), thereby enabling an evaluation of production performance from two standpoints. The findings revealed that the banking sector in the Western region was significantly more efficient than in the other regions with respect to the production of volume of advances and deposits. Therefore, policy makers should assess the volume of demand for banking services in each region and encourage the provision of cost-effective banking products tailored to meet the needs

of the different regions, and for banks to adjust their inputs with the aim of improving their efficiency. Socio-economic determinants of regional banking efficiency found in the empirical analysis are also important in formulating the policies needed for enhancing banking efficiency at the regional level.

(7) A productivity analysis of the banking sector at the national level revealed that both efficiency and technological change contributed to total factor productivity improvements during the reference period. However, TFP growth was found to be marginal in the post-conflict era under the operating approach. This is a result of the combined outcomes of low efficiency change and a lack of technological improvement. Therefore, policy makers should encourage investment in new technology and efficiency improvements while maintaining stability in the system.

The following section presents specific policy recommendations aimed at enhancing the performance of the banking industry in Sri Lanka at both the national and regional levels.

7.3 Institutional reforms in the banking sector

7.3.1 Expansion in branch networks

Despite a continuous expansion in branch networking for most of the banks in Sri Lanka after the liberalisation of the economy in 1977, differences in banking penetration in the Western region compared to other regions has prevailed for a long period of time. Bank branches have been highly concentrated in urban areas, particularly in the Western region, with all the commercial and specialised banks tending to expand their branch networks in urban areas. This reflected the greater demand for banking services in urban

areas, with a higher concentration of banking business, and this contributed to a further increase in regional economic disparities across the country. As a policy measure to minimise these disparities in banking services, the CBSL issued a directive in 2008 to all commercial and specialised banks in Sri Lanka to open two bank branches in other regions when they opened one bank branch in the Western region (CBSL 2013b; 2013c).

The broad aim of this expansionary policy in the banking sector was to achieve broad-based and inclusive growth in the medium and long run by eliminating disparities in access to finance (CBSL 2013b).[106] This policy directive effectively influenced the geographical expansion in bank branch networks in Sri Lanka, particularly after the end of the armed conflict. Despite the significant expansion in geographical coverage, the efficiency of the banking system, as identified previously in this study, has not declined, counter to views in mainstream literature. Further regression analysis has shown a lack of significant geographical expansion and growth of branch networks based on both intermediation and profit-oriented operational efficiency. Hence, the empirical findings indicate the success of the policy direction of the CBSL. Accordingly, this study suggests that geographical expansion of the banking sector is a viable and effective policy tool to achieve broad-based and inclusive growth in an emerging economy such as Sri Lanka's.

The higher efficiency recorded in the post-conflict period with respect to both intermediation and operating approach could be an outcome of the high demand for credit prevailing in the country, particularly in the post-conflict era. Private sector credit expanded by 25.1%, 34.5% and 17.6% in 2010, 2011 and 2012 respectively, and this

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[106] These policy directives were practised in developing countries such as India for improving access to finance in rural areas (Burgess & Pande 2003).

coincided with post-conflict economic recovery and expansion in the country (CBSL 2012a; 2013a). The high credit disbursement of the banking sector is a combined outcome of satisfying latent demand in line with post-conflict economic expansion and supporting development strategies used by the government, and development agencies targeting inclusive growth. In fact, this improvement in efficiency, by exploiting the advantages arising from high demand for credit along with economic expansion, can be considered as a peacetime dividend from the post-conflict era. This improvement in bank efficiency is also witnessed by the analysis focused only on commercial banks. Hence, continuation of the geographical expansion drive of bank branches could be an emerging challenge unless economic growth and development is sustained.[107] Further, the rate of Sri Lanka's economic growth has decreased in recent years with declining growth in the world economy. Therefore, policy makers and regulators may need to reassess the 2008 policy direction for promoting branch expansion by being more flexible in their directives for branch expansion.

7.3.2 Consolidation of the financial sector

The empirical evaluation of the intermediation efficiency levels of domestic commercial and specialised banks revealed that there is no significant difference between these two bank groups with respect to weighted aggregate efficiency which accounts for the size of banks' output. However, the results also revealed that the mean efficiency level of the specialised banks is significantly lower than that of domestic commercial banks, indicating inefficiency in the smaller specialised banks. One possible reason for this

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[107] There are two schools of thought with respect to the finance-growth nexus. First, the 'demand following' hypothesis argues that economic growth means high demand for financial services. Second, the 'supply leading' hypothesis explains economic growth as an outcome of better financial services.

inefficiency in specialised banks is their small scale of operations relative to the other domestic banks. Therefore, actions need to be taken to improve the efficiency of these small specialised banks. Among the seven specialised banks, none of them currently accounts for more than a 1.5% market share except for the National Savings Bank.

The CBSL has already announced a consolidation plan to promote mergers among small specialised banks and finance companies. The CBSL aims to enhance economies of scale, economies of scope, revenues, risk management systems, geographical dispersion and other benefits through consolidation. Mergers between small financial institutions, including specialised banks, through a financial sector consolidation plan was presented in 2013 (CBSL 2013a). The motivation for this move was the success of financial sector consolidation in a number of East Asian countries including Singapore, Korea, Taiwan and Hong Kong (Sufian 2007; Thoraneenitiyan & Avkiran 2009; Sufian 2009b).

Studies of East Asian nations mostly highlight efficiency and productivity improvements in the banking sector in the post-merger period (Peng & Wang 2004; Sufian 2004; Lin 2005; Thoraneenitiyan & Avkiran 2009; Sufian 2009b). As one of the most open economies in South Asia, Sri Lanka can also expect similar benefits through these proposed mergers. The CBSL has mostly proposed mergers between small financial institutions. However, the literature suggests that merging small banks with large banks in order to improve the efficiency of small banks can be more effective when the small banks are inefficient (Amel et al. 2004). Empirical results also reveal higher efficiency among the domestic commercial banks. These banks are generally much larger than the specialised banks. Therefore, mergers between domestic commercial banks and

specialised banks could be more effective for enhancing the efficiency of the banking sector while achieving stability in the financial sector. Seelanatha (2007) has suggested removing the limitations on the scope of the specialised banks in Sri Lanka to enhance their efficiency, since specialised banks are not allowed to engage in some commercial banking activities such as accepting demand deposits and engaging in forex operations. Mergers between specialised banks and commercial banks, however, would also remove this limitation on the specialised banks. Further, foreign bank can be encouraged for the partnership with specialised bank as the analysis only focused on commercial banks revealed the higher productivity of foreign banks driven by the technological changes during the reference period.

Consolidation involving mergers between specialised banks and finance companies, which have different business scopes, has also been suggested.[108] The management practices of these two types of banks are likely to be mismatched, however, due differences in the scope of these businesses and the expected cost reductions through mergers many not be realisable (Drake & Hall 2003). Further, the IMF has also highlighted in their article review IV for the year 2014 that the potential gains from merging banking institutions through economies of scale, increased market power and reduction in earnings volatility, could be minimal due to a lack of restructuring plans which include measures such as reducing staff costs or downsizing the workforce (IMF 2014). Therefore, consolidation plans should be focused on the cost reduction dimension arising from the mergers of banks.

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[108] A new financial company, the Merchant Bank of Sri Lanka and Finance PLC, has already been established through the amalgamation of the Merchant Bank of Sri Lanka (MBSL), MBSL Savings Bank, the MBSL PLC and MBSL Finance Services Ltd during 2015.

7.4 Establishing a competitive market environment

7.4.1 Promoting foreign investment in the banking sector

The study has found that productivity improvements for the foreign banks during the period 2006–2014 were driven by technological advancements. The average and aggregate operational efficiency of the foreign banks was the highest among the three groups of banks considered in this study. This indicates a higher level of operational efficiency for the foreign banks on average as well as for foreign banks as a group. Further, foreign banks use a superior technology set according to the MRTs ratio with respect to both the intermediation and operational approaches. Efficiency analysis focused only on commercial banks also confirmed this. Therefore, the domestic banking sector can benefit from positive spillovers such as from technology diffusion and risk management practices with higher foreign investment in the banking sector, in line with the mainstream efficiency-ownership nexus literature (Havrylchyk 2006; Staikouras et al. 2008). However, the extent of foreign participation in the banking sector is not at a satisfactory level despite the country having opened its banking sector to foreign banks some 40 years ago in 1977.[109] The combined market share of foreign banks is still only around 10%. Therefore, policy makers need to revisit the strict regulations on the banking sector in order to identify key barriers to foreign participation in the industry.

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[109] The history of foreign bank presence in Sri Lanka goes back to the pre-independence era. Foreign banks operated in Sri Lanka when the country achieved independence in 1948. Until 1977 a limited number of foreign bank branches operated in the country due to restrictions imposed by regulators on foreign participation in the banking industry.

The mandatory requirement that at least 10% of the funds lent by locally incorporated banks must go to the agriculture sector could be one of the demotivating factors for foreign participation in the banking industry of Sri Lanka. Therefore, a new subsidy scheme operating through direct government spending could be introduced for the agriculture sector with the aim or replacing the current mandatory lending requirement. Directives issued by the CBSL regarding the opening of two branches outside the Western region for each branch opening within the Western region may also have a negative impact on foreign investment in the banking sector. Foreign banks can have a lower efficiency level in regional areas due to informational asymmetries, lack of knowledge of new market conditions and insufficient assessment of socio-economic conditions (Bhattacharyya et al. 1997; Buch 2003; Das & Ghosh 2006; Bhattacharyya & Pal 2013). In addition, although there are no specific barriers to foreign bank entry, foreign banks are only allowed to enter into the market after an assessment of their business model by the CBSL. It would be better if the CBSL could introduce a more transparent procedure for this assessment to encourage foreign investment in banking.

7.5   Strengthening the regulatory and prudential framework

7.5.1   Encouraging the capital adequacy of banks

Results from the empirical analysis presented in this study show a negative and statistically significant relationship between the capital ratio and the efficiency of the commercial banks with respect to operational services, which is in line with Akhigbe and McNulty (2005) and Sufian (2009a). This finding implies that more efficient commercial banks, ceteris paribus, use less capital (and more leverage) than other less efficient commercial banks. A commercial bank may be less efficient due to the maintenance of

higher capital ratios. Maintaining a higher capital ratio could be due to regulatory pressure from capital adequacy requirements imposed by the CBSL.

During the period of this study, 2006–2014, risk management was at the top of the policy agenda for the CBSL. A number of measures were taken by the CBSL to improve the risk management of financial sector institutions in the country and were introduced on a staggered basis and in line with the standards defined in by the Basel committee. Although most domestic banks in Sri Lanka record capital ratios above the requirement set by the CBSL, the empirical results indicated that imposing continuous and aggressive capital adequacy levels could exert downward pressure on their operational efficiency. Therefore, policy makers should be cautious in implementing measures aimed at improving capital adequacy in the banking sector, especially with respect to enhancing the stability of the sector. The implementation of long-term plans for enhancing banking sector capital strength would be useful for achieving a smooth increase in the capital ratio and avoiding pressure on the banking system.

7.6   Regional development and banking efficiency

7.6.1   Overcoming lower production efficiencies in the regional banking sector

The lower production efficiency of the banking sector in the non-Western regions, as revealed by the regional level empirical analysis, is an issue that needs to be addressed by policymakers in Sri Lanka, with the aim of achieving balanced regional growth in the post-conflict period. Bankers are also concerned about the production efficiency of their financial institutions. Lower production efficiency may discourage bank management from expanding banking services into the non-Western regions and this could, perhaps,

also lead to the closure of regional banking outlets in the long run. The possible closure of banking outlets in regional areas could directly, and adversely, influence access to finance in these regions which is a prerequisite for attaining the envisaged balanced regional growth objective set by policymakers (Jeanneney & Kpodar 2011; Kendall 2012). Production efficiency is significantly lower in the non-Western regions when output is measured in monetary units. The lower production efficiency of deposits and loans reflects the underutilisation of resources in the non-Western regions. This could influence the regional development process if the banks are not producing the outputs needed to meet the prevailing demand for banking services in those areas. Paradi and Schaffnit (2004) suggested output augmentation through the popularising of banking products if there is growth potential for banking services in an area. However, if the banking institutions decide not to expand their output in regional areas due to high returns on funds in the Western region, policy makers would not be able to achieve the objective of balanced regional growth. Therefore, Sri Lankan policy makers could also encourage banks to expand their services and customer base in regions where there is sufficient recorded demand for banking services.

Further, the CBSL could share information and research data with the banks which intend to expand their branch network in non-Western regions to avoid the establishment of bank branches in areas with lower demand for banking services. Policy makers and bankers can also focus on cost-effective and innovative banking products with the aim of improving production efficiency. Expansion in post-office and school banking units could also be a cost-effective means of expanding banking facilities in regional areas. The potential of internet banking as a cost-effective tool for improving banking services

should also be assessed since computer literacy in the rural sector of Sri Lanka was 25% by the end of 2015 (DCS 2014).

A reduction in the cost of loan disbursement could also be a challenge due to the lengthy and time consuming credit evaluation procedures followed by banks. Higher administrative fees on small loans can also be a discouraging factor for loan disbursement in regional areas.[110] Therefore, the decentralisation of more powers to the regional level for loan disbursement may be helpful for reducing the time and costs involved in loan administration.

7.6.2   Adjusting banking sector performance for population density

The empirical evidence presented in Chapter 6 indicates a positive relationship between bank efficiency in generating volume of advances and deposits and the population density of the region. A lower bank efficiency level can be caused when the demand for banking services is not enough for the efficient collection of deposits and the disbursement of advances given the inputs of the banks. This has also been supported in the banking efficiency literature (Lozano-Vivas et al. 2002; Maudos et al. 2002b). However, the directions issued by the CBSL to open two branches outside the Western region for each bank branch opening in the Western region should be maintained in order to improve access to finance in areas with a low population density. It has been empirically demonstrated that a similar bank branch expansion program introduced by the Reserve Bank of India during the period 1977–1990 stimulated regional output and decreased poverty levels in rural areas (Burgess & Pande 2003). Therefore, banks should be

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[110] Administrative cost as a percentage of the loan is mostly higher for small scale lending due to common and lengthy credit evaluation procedures used irrespective of the size of the loans in general.

encouraged to adopt cost-effective banking service models suitably adapted to meet the needs of areas with low population density. The CBSL can encourage banks to operate mobile bank branches in areas with low population density instead of permanent branches. A summary of the major policy recommendations is provided in Table 7.1.

Table 7.1: Summary of policy recommendations relating to the Sri Lankan banking sector

Findings	Opportunities, challenges and limitations	Implications for policy makers
No evidence of a negative relationship between geographical expansion and growth in branch networks.	Use geographical expansion and growth in branches in banking sector as a policy tool to improve access to finance and address the policy issue of attaining broad-based and inclusive growth.	The findings of the study do not support the idea of a likely decline in banking efficiency due to branch expansion as asserted in the mainstream literature. Policymakers can use expansion of the branch network, particularly geographical dispersion, as a viable and effective policy tool to improve access to finance. Use this tool with caution, however, since the efficiency of the banking sector can decline if there is over-branching by banks.
Lower level of operating efficiency in small specialised banks	Improve efficiency in the post-merger period.	Merge small specialised banks and commercial banks to achieve higher intermediation efficiency in the post-merger period. Discourage mergers between specialised banks and finance companies to avoid a possible efficiency decline due to management mismatches as indicated in the literature.
Higher productivity, more advanced technology set and greater operating efficiency of the foreign banks	Establish a more conducive environment for foreign banks Encourage foreign affiliation with domestic banks.	Remove mandatory lending to the agriculture sector for both foreign and domestic banks and replace this with subsidies to the agriculture sector by the government. Assess the possibilities of exempting foreign banks from compulsory branch opening. Introduce a more transparent evaluation procedure for the entry of foreign banks into the Sri Lankan banking industry.
Negative relationship between capital ratio and operating efficiency with respect to the commercial banks	A further decline in the operating efficiency of commercial banks is likely with continuous	Implement long-term plans for enhancing banking sector capital strength to avoid stress on banking institutions.

Table 7.1: Summary of policy recommendations relating to the Sri Lankan banking sector

Findings	Opportunities, challenges and limitations	Implications for policy makers
	measures aimed at increasing capital adequacy.	
Lower production efficiency of the banking sector in regions other than the Western region.	Closure of branches and a deceleration in further branch expansion in regions other than the Western region.	Promote cost-effective means of providing banking facilities such as post-office branches and school banking units instead of conventional bank branches.
Negative relationship between population density and bank production efficiency	Providing access to finance in regional areas.	Introduce mobile banking units for areas with low population density and avoid establishment of conventional bank branches. Also, encourage the use of internet banking.

7.7 Summary

The policy implications and recommendations for the further development of the banking sector in Sri Lanka have been presented in this chapter. The policy implications and recommendations are grounded on the empirical evidence presented in the study consisting of: (1) an analysis of changes in banking efficiency and the technology set of Sri Lankan banks before and after the end of the armed conflict, and between different banks groups based on ownership, (2) assessment of the determinants of banking efficiency and changes in banks' productivity in Sri Lanka during the period 2006–2014, (3) a comparison of regional level production efficiencies of the banking sector and an assessment of their socio-economic determinants.

In particular, this study has suggested institutional reforms, establising a more competitive banking market environment, strengthening the regulatory and prudential framework, and targeting the reform of regional level banking activities with the aim of: improving their efficiency and productivity, achieving inclusive and broad-based growth, within the context of a stable, sound and dynamic banking sector. In order to achieve higher efficiency and productivity of Sri Lankan banks, specific policies should be trageted including: (1) the use of branch expansion as a policy tool to achieve balanced regional growth, (2) encourging mergers between small specialised banks and large efficient commercial banks, (3) establishing a more conducive environment for foreign participation in the banking industry including a transparent evaluation procedure at entry, (4) implementing long-term plans aimed at enhancing the capital strength of the banks, (5) promoting cost-effective means of introducing banking facilities in regional

areas, (6) discouraging conventional branch opening in areas with low level population densities.

The next and final chapter presents the major conclusions and a summary of this study, along with a discussion of the limitations of the analysis and some suggestions for future research.

Chapter 8   Summary and conclusion

8.1   Introduction

Literature on the finance-growth nexus has confirmed the active and important role of the financial sector in economic development in both emerging and developed nations (Goldsmith 1969; Shaw 1973; McKinnon 1974; King & Levine 1993). Therefore, as a critical component of the financial sector, an efficient banking system plays a vital role in economic expansion, particularly in developing countries where capital markets may be underdeveloped. In the Sri Lankan banking sector efficiency and productivity are both crucial for economic growth, where the banking sector accounts for around 78% of financial sector assets (CBSL 2014).[111]

Being the first country in the South Asian region to liberalise its economy in 1977 with the initiation of financial sector reforms, Sri Lanka was able to increase private sector participation in the banking sector, particularly from the late 1980s. In the banking industry the private sector outperformed the state-owned banks in the early 2000s with continued reforms in the banking sector (Hemachandra 2013). However, state-owned banks recorded wider outreach than private banks in line with the government's objective of improving access to finance, especially for the population living in regional areas. Prudential measures for stability and soundness of the banking system were also introduced continually by the CBSL during this period. Over the last decade all the

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[111] The banking sector's contribution to financial sector assets would increase up to 90% if EPF and ETF were excluded from financial sector assets. As mentioned in Chapter 2, EPF is the superannuation fund comprising mandatory contributions made by employees and employers.

players in the banking market have experienced a relatively symmetric market environment, enabling intense competition among them.

Although policy makers continued to liberalise the banking sector with regulatory reforms, the banking sector, and economy as a whole, were unable to exploit the potential benefits as a consequence of deteriorating security conditions in the country due to the armed conflict in the Northern and Eastern regions. After the end of the 26-year armed conflict in 2009, the country achieved impressive growth for a couple of years despite the fragile economic conditions in Europe which is the major export destination of the country. A conducive economic environment and improved security conditions provided more opportunities for the banking sector. Therefore, the banking sector expanded during the post-conflict era with higher credit expansion. In addition to credit expansion, the geographical dispersion or coverage of branch networks, as well as their numbers, also increased with the opening of new branches in the Northern and Eastern regions. The prudential measures and reforms implemented by the CBSL during the reference period 2006−2014 were mainly targeted at improving risk management, corporate governance, ownership structure, geographical dispersion of branches and regulatory asymmetries in the banking sector.

Therefore, the main aim of this study has been to empirically evaluate efficiency and productivity in the Sri Lankan banking sector and to assess the impact of other factors on efficiency and productivity. In achieving this objective the study has addressed the following research questions highlighted in Chapter 1: 1) Did banking sector efficiency and productivity increase in the post-conflict period? 2) Has there been a significant difference between the efficiency and productivity of foreign commercial, domestic

commercial and domestic specialised banks in Sri Lanka during the reference period? 3) Has banking sector efficiency been affected by the growth of branch networks, geographical dispersion and other related factors? 4) How has banking efficiency changed across the regions and what is the impact of socio-economic factors on regional level banking efficiency? This chapter summarises the major findings with respect to these questions and the contribution of this thesis to the literature in the context of a developing economy. The remainder of the chapter is structured as follows. Section 8.2 summarises the major findings from previous chapters. A brief description of the key policy implications and recommendations for further development of the Sri Lankan banking sector and its contribution to attaining development objectives is provided in Section 8.3. Section 8.4 explains the limitations of the study. Finally, suggestions for future research in the area of banking efficiency and productivity are provided in Section 8.5.

8.2 Summary of the major findings

The research questions raised in Chapter 1 have been systematically addressed by the thesis. This section summarises the major findings of the study with respect to each of these research questions.

Did banking sector efficiency and productivity increase in the post-conflict period?

In order to evaluate banking sector efficiency in the post-conflict era the sample of bank observations used in this study for the period 2006–2014 is divided into two groups: the data for the period before the end of the conflict (2006–2009) and data for the period after the end of the conflict (2010–2014). Simar and Zelenyuk's aggregate efficiency measures and the Li test with bootstrap sub-sampling technique were employed for the purpose of

comparison between the two groups. An increase in aggregate efficiency in the post-conflict era relative to the period before the end of the conflict indicated an improvement in the efficiency of the banking industry. The Li test also revealed differences in the efficiency levels of the banks in the periods before and after the conflict. Therefore, the findings from this study have confirmed an improvement in the efficiency of the banking industry in the post-conflict period as against the period before the end of the armed conflict with respect to both the intermediation and operational approaches. An improvement in banking sector productivity was also observed based on the results of the MPI. This improvement in banking sector performance can be considered as a peace dividend achieved as a result of post-conflict economic expansion which enhanced the opportunities for banks to exploit advantages arising from a high demand for banking services. The findings are also valid when the commercial banking sector is focused excluding specialised banks.

Overall, it can be concluded that the banking sector in Sri Lanka is well positioned in the post-conflict era to provide intermediation services while maintaining operational efficiency with limited but prudent government and regulatory interventions.

Is there a significant difference in efficiency and productivity between foreign commercial, domestic commercial and domestic specialised banks in Sri Lanka during the period 2006–2014?

Differences in efficiency have been evaluated among the three bank groups which were the focus of this study, namely foreign commercial, domestic commercial and domestic specialised banks in order to address the above research question. The findings revealed

a superior efficiency performance of domestic commercial and domestic specialised bank groups compared to foreign banks in providing intermediation services. However, foreign banks outperformed the domestic banks in using a profit-oriented operating approach, confirming their focus on profit maximisation. When the efficiency of the state-owned and private commercial bank groups was compared, it was found that the state-owned commercial banks were more efficient than the private commercial banks in terms of the provision of intermediation services. Significant differences were not observed between them in terms of profit-oriented operational efficiencies, reflecting the competitiveness of state-owned commercial banks in terms of profitability. This can be considered as a likely outcome of the continuous reforms that have been implemented which the aim of minimising government influence on state-owned banks. Significant increases in productivity have been recorded by the domestic commercial banks with respect to intermediation services, particularly in the post-conflict era in an environment of higher demand for banking services and expansion in branch networks. This increase was driven by the technology changes. Higher productivity improvement was recorded by the foreign banks relative to the domestic commercial and domestic specialised banks with respect to profit-oriented operations during the study period. This was also mainly due to changes in technology.

Is banking sector efficiency affected by the growth of branch networks, geographical dispersion and other related factors?

The study sought to identify the relationship between banking sector efficiency on the one hand, and growth in branch networks, their geographical dispersion and other important variables on the other. To do this, a truncated regression model, as presented

in Chapter 5, was used and this included a number of explanatory variables. The growth in branch networks and their geographical dispersion were proxied by the annual percentage increase in the number of branches and the percentage of bank branches outside the Western region respectively. The findings revealed that there was no significant negative relationship between banking sector efficiency and an increase in the number of banks in branch networks or their geographical expansion as asserted in the mainstream literature. In fact, geographical dispersion had a positive relationship with operational efficiency when all the commercial and specialised banks were included in the sample. The findings are also valid even for the commercial banking sector excluding the specialised banks.

Among the other explanatory variables included in the regression model, capital strength, measured by equity as a percentage of assets, indicated a positive relationship with the efficiency of intermediation services. However, the relationship was found to be negative for commercial banks when efficiency was measured based on the operating approach. The model revealed that the following factors had a positive influence on both the intermediation and operational efficiency of banks: credit risk, as measured by the NPA ratio; the assets structure, as estimated by the loans to assets ratio; and the size of the banks, as estimated by their total assets. The profitability of the banks, as proxied by ROA, was found to have a positive relationship with banking efficiency and the relationship was significant with respect to operational efficiency. Among the control variables included in the model the relationship between GDP and efficiency was negative, with a declining trend in economic growth in the post-conflict period with improved efficiency. The relationship between efficiency and the type of ownership

(foreign or domestic) was also found to be significant with respect to profit-oriented operations. A positive relationship was observed between the time trend and efficiency, providing evidence of an improvement in banking performance during the study period.

How has banking efficiency changed across the regions and what impact do socio-economic factors have on regional level banking efficiency?

The banking efficiency of nine regions in the post-conflict period in Sri Lanka were analysed to identify regional disparities in banking performance, and to provide the basis for recommendations for how to address these disparities. With the aim of comprehensively analysing regional banking performance, the aggregate production efficiency of banks in each region was calculated. To do this, two aspects of output were measured: quantity (number of advances and deposits) and monetary values (volume of loans and deposits in Sri Lankan rupees). The study did not reveal significant differences in efficiency between the rich Western region and other regions when output was measured in terms of the number of advances and deposits. However, banking sector efficiency in the Western region was found to be significantly higher when output was measured with respect to the volume of advances and deposits. Further, the study revealed stronger correlations between bank efficiency and socio-economic conditions when output was measured by the number of advances and deposits. In addition the study confirmed validity for these regional differences in banking efficiency with respect to the commercial banking sector excluding specialised banks.

8.3 Policy implications and recommendations

The empirical analysis proved that the Sri Lankan banking sector is operating far from its

optimum level of efficiency and that there are differences in the performances of bank groups and regions. Therefore, this study has highlighted a number of policy implications and made recommendations for policy makers in Sri Lanka, targeting improvements in banking sector performance in four broad areas. First, the study suggests the following institutional reforms in the banking sector with respect to branch expansion and an ongoing consolidation plan in the banking sector.

- Use branch expansion as a policy tool to help achieve the medium-term goal of improving access to finance and the long-term goal of achieving broad-based and inclusive growth with caution, since branch expansion could lead to a decline in efficiency with poor credit growth if economic growth was too slow.

- Encourage mergers between small specialised banks and efficient commercial banks to improve banking efficiency in the post-merger period. Further, discourage mergers between banks and finance companies to avoid possible declines in efficiency due to mismatches in business scope and management strategies.

Second, policy makers should encourage a competitive market environment in order to improve banking sector efficiency. The regulatory bottlenecks facing foreign banks should be removed to encourage technology spillover from foreign banks to domestic banks to promote higher efficiency, especially with respect to operational services. The rule requiring banks to open two branches in regional areas for every one that they open in the Western region, and mandatory lending to agriculture may also discourage foreign banks from entering the market. Therefore, the impact of these regulatory directions on

foreign bank entry and operation in the country should be assessed and revised in order to encourage greater foreign participation.

Third, capital risk should be minimised with the imposition of a minimum capital requirement on banks while maintaining a healthy efficiency level in the banking sector. The continuous and aggressive enforcement of higher capital requirements may have a negative impact on domestic banks' efficiency. Therefore, a long-term plan could be implemented to enhance the capital strength of the banks to sustain their efficiency levels.

Fourth, the low production efficiency in advances and deposits in non-Western regions could be addressed through cost-effective banking products such as school banking, post-office branches and internet banking. Mobile banking units could also be introduced to in areas with low population density as the empirical analysis revealed the negative relationship between efficiency and population density. Further, CBSL could share information and research data with the banks to avoid the establishment of bank branches in areas with lower demand for banking services. The decentralisation of more powers to the regional level within the banks for loan disbursement could also be useful for reducing the time and costs involved in loan administration to improve banking efficiency at the regional level.

8.4 Limitations of the study

A number of factors can be identified as representing limitations of this study. First, the period from 2006 to 2009 is defined as the period before the armed conflict for comparison with the post-conflict period. However, the armed conflict was 26 years long

and ended in 2009. Therefore, the period 2006–2009 may not accurately represent the whole conflict period. However, the period 2006–2009 was in fact the worst period of the conflict, and during this period there was considerable deterioration in the security conditions of the country. The banking sector data, particularly with respect to foreign banks, only became available after the CBSL made it compulsory for all the banks to publish their accounts, which occurred in 2006.

The regional comparison of banking efficiency was based only on data for private banks, although state-owned banks also play a key role in regional banking. The data sample was limited to private banks due to the unavailability of regional level data for state-owned banks. In addition, bank-specific variables at the regional level were not included as control variables in the two-stage regression model used to find the impact of socio-economic factors on efficiency. This was due to the unavailability of regional level bank-specific data.

The production approach was used to assess the banking sector aggregate efficiency measures for each region. Efficiency measures based on an intermediation approach are more important for comparing efficiency levels between the regions and for evaluating the socio-economic determinants of efficiency, since intermediation is the core banking activity which influences regional growth. However, an intermediation approach was not used due to the unavailability of data on inter-regional fund flows. This was mainly due to the use of aggregate financial and operational information for the nine regions for each bank in the analysis. Banks are not concerned about inter-regional fund flows since they

operate as a one bank covering all regions. Therefore, analysis of intermediation efficiency at the regional level was not possible.

The GMPI was used to evaluate productivity changes in the banking sector during the 2006−2014 period. In the absence of an aggregate measure which accounts for the size of a bank's output, the geometric average value of the Malmquist index was used for a group comparison of productivity and to evaluate changes in productivity. Use of the aggregate Malmquist index as introduced by Zelenyuk (2006) was not possible due to the infeasibility of solutions, particularly in the context of VRS which is more suitable for banking studies.

8.5 Future research in the area of banking efficiency and productivity

The empirical evidence presented and the limitations of this study pave the way for further research into new areas of efficiency and productivity measurement. The scope of this study could be expanded to include a comparative analysis involving other South Asian nations which have similar social and economic environments to that of Sri Lanka. This would provide a holistic view of banking sector performance (in regard to efficiency and productivity) in the South Asian region which has always used collective efforts to overcome common challenges. In addition to the commercial and specialised banks, the Sri Lankan financial sector comprises other institutions such as leasing banks, corporative banks and finance companies. Therefore, an intra-industry analysis of efficiency and productivity would be useful for formulating broader policies for financial sector development.

The development of GMPI for comparing efficiency and productivity changes between different groups while taking account of the output size of each firm could be another area of research. The possible bias of this proposed aggregate global Malmquist index could be minimised by introducing bootstrap confidence intervals. Further, the truncated regression analysis used in this study could be extended by incorporating conditional efficiency measures as proposed by Daraio and Simar (2014). Although the double-bootstrap truncated regression model was established on the assumption of mutual exclusiveness between production sets and environment variables, conditional efficiency provides for possible interactions and such interactions are common.

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APPENDIX A

Table A.1: Regional GDP shares (%)

Region	Year 1997	Year 2014
Western	44.3	42.0
Central	10.5	10.3
Southern	8.8	10.8
Northern	2.8	3.6
Eastern	5.0	5.8
North Western	12.1	10.7
North Central	4.0	5.1
Uva	5.0	5.0
Sabaragamuwa	7.6	6.7
Sri Lanka	100.0	100.0

Source: Central Bank of Sri Lanka

Table A.2: Human Development Index of Selected Asian Countries

Country	Year 1960	1970	1980	1990	2000	2010	2013
Sri Lanka	0.48	0.51	0.56	0.61	0.65	0.71	0.75
Bangladesh	0.17	0.20	0.31	0.36	0.43	0.51	0.56
India	0.21	0.25	0.35	0.41	0.46	0.55	0.59
Nepal	0.13	0.16	0.23	0.34	0.40	0.46	0.54
Indonesia	0.22	0.31	0.42	0.48	0.54	0.62	0.68
South Korea	0.40	0.52	0.64	0.75	0.84	0.88	0.89
Malaysia	0.33	0.47	0.56	0.64	0.71	0.76	0.77
Philippines	0.42	0.49	0.56	0.58	0.61	0.65	0.66
Singapore	0.52	0.68	0.77	0.84	0.87	0.89	0.90

Source: World Bank

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APPENDIX B

Table B.1: Selected Literature on the Determinants of Banking Efficiency

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
Hou et al. (2014)	China	2007–2011	DEA and truncated regression based on bootstrap simulation	Technical Efficiency	Positive relationship between risk taking and bank technical efficiency	**Environmental Variables:** Market structure (Herfindahl–Hirschman Index in deposits), ratio of equity to total assets, loss provisions of loans, ratio between total loans and deposits, total assets, ownership type, GDP growth rate and return on assets **Inputs:** Deposits, labour and fixed assets **Outputs:** Total net loans and other earning assets **Approach:** Intermediation approach
Matthews and Zhang(2010)	China	1998–2007	DEA and MPI based on bootstrap simulation	Productivity	There is no significant impact on bank productivity from financial liberalisation	*Impact of environmental variables on efficiency or productivity was not tested.* **Inputs:** Deposits (RDEP), overheads (ROHD), fixed assets (RFA), **Outputs:** Loans, other earning assets, net fee income, non-performing loans (undesirable output), deposits, net interest earnings. **Approach:** Five models based on a mix of the intermediation and production approaches

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
						(Different combinations of the above inputs and outputs were incorporated into five models)
Das and Kumbhakar(2012)	India	1996–2005	SFA and MPI	Cost Efficiency, Technical efficiency and Productivity	Improvement in productivity and efficiency in the post-deregulatory period was found	*Impact of environmental variables on efficiency or productivity was not tested.* **Inputs:** Labour, fixed assets **Outputs:** Deposits, loans, number of deposit accounts and number of loan accounts. **Approach:** Mix of Intermediation and production approach
Sufian (2011b)	Malaysia	1995–2004.	Banks total factor productivity change in a developing economy: Does ownership and origins matter? (MPI)	Productivity	Foreign banks are less productive than domestic banks	**Environmental Variables:** Loan loss reserves, total assets, non-interest expenses, non-interest income, return on assets, return on equity, GDP and the inflation rate. **Inputs:** Deposits, labour, deposits and fixed assets. **Outputs:** Loans, Investment and non-interest income **Approach:** Intermediation

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
Kumar (2013)	India	1992–2008	DEA	Convergence of cost, technical and allocative efficiency	Deregulation has had a positive impact on the cost efficiency of public sector banks (PSB). PSBs's cost efficiency is driven by technical efficiency.	*Impact of the environmental variables on efficiency or productivity was not tested.* **Inputs:** Physical capital, labour, deposits and borrowing. **Outputs:** Net interest income and non-interest income **Approach:** Intermediation
Kenjegalieva & Simper (2011)	12 Central and Eastern European (CEE) countries[112]	1998–2003	DEA based Luenberger productivity Index	Regional level Productivity and risk	The main driver of productivity change is technological improvements. Risk management is one of the main factors contributing to technological improvement particularly in later periods. No significant differences in bank productivity across the countries.	**Environmental Variables:** GDP per capita, GDP deflator, GDP change, inflation, inflation change, unemployment rate and corruption **Inputs:** Deposits and short-term funding, personnel expenses, Total fixed assets, other operating expenses **Outputs:** Loans, other earning assets, net interest income, non-interest income, deposits and short-term funding, loans loss provision (undesirable) **Approach:** Intermediation, production and profit/revenue

[112] The sample of 12 CEE countries consists of Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Croatia, Romania, Russia, Moldova and Ukraine.

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
Halkos and Tzeremes (2013)	Greece	2007–2011	DEA based on bootstrap simulation	Technical efficiency	Findings do not support the view that mergers or acquisitions between efficient banks will form an efficient banking group.	*Impact of environmental variables on efficiency or productivity was not tested.* **Inputs:** Deposits, labour & physical capital **Outputs:** Loans and securities **Approach:** Intermediation
Andries (2011)	Seven Central and Eastern European (CEE) countries[113]	2004–2008	DEA, SFA, MPI & OLS regression	Regional and country comparison of technical efficiency and productivity	Productivity of the banking sector has been improved during the reference period largely due to technological advancement in the banking industry. Significant changes in technical efficiency across the countries have been identified.	**Environmental Variables:** Equity, size of the bank, size of the banking system, return on average equity, return on assets, GDP growth, inflation rate, ownership, NPL, private domestic credit, level of concentration, refinancing rate, interbank market rate, deposit rate and lending rate. **Inputs:** Deposits & borrowings, fixed assets and operational expenses **Outputs:** Loans, securities and other income **Approach:** Intermediation

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[113] The seven Central and Eastern European (CEE) countries are Bulgaria, the Czech Republic, Poland, Romania, Slovakia, Slovenia and Hungary.

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
Ayadi et al. (2013)	42 banks in the EU 15[114] countries and Norway	1996–2003	Free Aggregation Hull framework (FAH)	Technical efficiency	Convergence of technical efficiency level of European banks arising from mergers and acquisitions. Productivity improvement is not significant in the post-merger period.	*Impact of environmental variables on efficiency was not tested.* **Inputs:** Labour, physical capital and borrowed funds **Outputs:** Loans and investment assets **Approach:** Intermediation
Burki & Niazi (2010)	Pakistan	1991–2000	DEA & Tobit Regression	Cost efficiency	Bank size, asset quality and number of bank branches influence bank efficiency. Private and foreign banks are superior to the state-owned banks in terms of efficiency.	**Environmental Variables:** Interest Income, loans, ownership, NPL and number of branches **Inputs:** Labour, physical capital, financial capital and operating cost **Outputs:** Loans, investment & contra accounts balance **Approach:** Intermediation
Das & Gosh (2006)	India	1992–2002	DEA and Tobit Regression	Technical Efficiency	Higher efficiency was recorded by state-owned banks relative to private banks. Banking sector	**Environmental Variables:** Ownership, size, ratio of capital to risky assets, ROA and management quality **Inputs:** Deposits, operating expenses and labour **Outputs:** Loans and investments

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[114] Countries coming under the EU15 area are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
					efficiency is dependent on bank size, ownership, capital adequacy ratio and non-performing loans.	**Approach:** Intermediation **Inputs:** Labour, capital and interest expenses. **Outputs:** Advances, investments and deposits **Approach:** Value-added **Inputs:** Interest expenses, Labour and capital related operating expenses **Outputs:** Interest income and non-interest income **Approach:** Operating
Havrylchyk (2006)	Poland	1997–2001	DEA & Tobit Regression	Technical efficiency	Foreign banks exhibit higher efficiency than domestic banks.	**Environmental Variables:** Capital structure, loan-loss provisions, growth of assets, ownership type, mergers & acquisition and location of head office **Inputs:** Deposits, fixed assets and labour **Outputs:** Loans, T-bills and off-balance sheet items **Approach:** Intermediation
Worthington (2001)	Australia	1993-1997	DEA/ Tobit model	Technical efficiency	Technical efficiency of credit unions in Australia have increased with mergers during the reference period.	**Environmental Variables:** Non-interest income, IT expenses, proportion of real estate loans and commercial loans, marketing expenses and mergers. **Inputs:** Physical capital, deposits and interest & non-interest expenses **Outputs:** Loans, Investment and interest & non-interest income

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
						Approach: Value-added intermediation approach
Berger & De Young (2001)	US	1993–1998	SFA & OLS Regression	Cost efficiency	The negative impact of branching on cost efficiency of the banks could be overcome through superior skills, policies and practices of the parent bank.	**Environmental Variables:** Assets, competition, region and mergers **Inputs :** Purchased funds, deposits and labour **Outputs:** Loans and securities **Approach:** Intermediation
Bos & Kolari (2005)	US and Europe	1995–1999	SFA & Logistic Regression	Cost efficiency	Potential efficiency gains are possible via geographic expansion of large European and US banks.	**Environmental Variables:** Total distances between all branches, size and geographical location **Inputs:** Financial capital, physical capital and labour **Outputs:** Loans, investment and off-balance sheet items **Approach:** Intermediation
Rezitis (2008)	Greek	1993 – 2004	SFA , Malmquist productivity index and OLS Regression	Technical efficiency and Productivity	Decline in technical efficiency of Greek banks in post-merger period. Study further highlighted the decline in total factor	**Environmental Variables:** Mergers, number of branches, change of market share and change of market concentration **Inputs:** Labour and capital expenses **Outputs:** Deposits and loans

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
					productivity in post-merger period.	**Approach:** Production
Isik & Hassan (2002)	Turkey	1988–1996	DEA & GLS Regressions	Cost efficiency	Efficiency and productivity gains recorded by banking sector after the deregulation of Turkish banking sector. One source of inefficiency in banking sector is identified as diseconomies of scale.	**Environmental Variables:** Size, risk, total loans, ownership category, ROA, ROE and age **Inputs:** Labour, Physical capital and Loanable funds **Outputs:** Loans, off-balance sheet items and other earning assets **Approach:** Intermediation
Demir et al. (2005)	Turkey	1991–1998	SFA	Technical efficiency	The quality of the earning assets of commercial banks was improved by the deregulation. Loan quality, size, ownership of the banks and profitability have been identified as determinants of efficiency.	**Environmental Variables:** Size of the assets & loans, non-performing loans, profitability and ownership type **Inputs**: Labour, deposits, borrowed funds and equity **Outputs:** Total loans and securities **Approach:** Intermediation

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
Hasan & Marton (2003)	Hungary	1993–1998	SFA & OLS Regression	Profit efficiency	Higher share of foreign ownership was associated with lower inefficiency in banking institutions. Local market conditions provide opportunities for foreign banks to exploit comparative advantages and improve the cost efficiency.	**Environmental Variables:** Loans, equity, liquid assets, cost efficiency, hours service available, years in business, ownership type and acquisition **Inputs:** Labour and deposits **Outputs:** Loans, investment, deposits non-interest income and interest income **Approach:** Intermediation
Ataullah & Le (2006)	India	1992–1998	DEA, OLS regression & GMM regression	Technical efficiency	Improvements in efficiency particularly in foreign banks after economic reforms were revealed by the findings. Further study highlighted the relationship between market competition and efficiency.	**Environmental Variables:** Total assets, earnings, investments, ROA, budget deficit, competition, private investments and foreign ownership **Inputs:** Interest expenses & operating expenses **Outputs:** Interest income and non-interest Income **Approach:** Operating
Xiaoqing Maggie & Heffernan (2007)	China	1985–2002	SFA and OLS regression	Cost X-efficiency	On average, higher X-efficiency was recorded from the joint-stock banks	**Environmental Variables:** Ownership, stage of reforms, purchase funds, total loans, total investment and non-interest income.

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
					relative to the state-owned commercial banks. Privatisation of banks, higher foreign bank participation, and interest rates liberalisation improved the cost X-efficiency.	**Inputs:** Fixed assets, labour and interest expenses **Outputs:** Loans, Investment, deposits non-interest income **Approach:** Intermediation
Hermes & Nhung (2010)	4 Latin American[115] and 6 Asian countries[116]	1991–2000	DEA	Technical efficiency	Strong evidence for the positive impact of financial liberalisation on banking efficiency.	**Environmental Variables:** Liberalisation, density of demand, GDP, inflation, equity, ROE, and loans **Inputs:**Labour, physical capital and interest expenses **Outputs:** Loans and other earning assets **Approach:** Mixed approach
Chortareas et al. (2013)	27 European Union member states	2001–2009	DEA	Technical efficiency	Economic freedom has positive correlation with banking sector technical efficiency	Financial freedom, equity, ROE ratio, assets, loans, **Environmental Variables:** Accountability, political stability, government effectiveness, regulatory quality, rule of law and corruption

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[115] Argentina, Brazil, Peru and Mexico
[116] India, Indonesia, Korea, Pakistan, Philippines and Thailand

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
						Inputs: Labour, physical capital and loanable funds
						Outputs: Total demand deposits and total net loans
						Approach: Intermediation
Denizer et al. (2007)	Turkey		DEA & OLS regression	Technical efficiency	Decline in efficiency and productivity in Turkish banking system after deregulation.	**Environmental Variables:** Inflation and GDP
						Inputs: Resources used for production, operational expenses, interest and fees and
						Outputs: Total deposits and non-interest income
						Approach: Production
						Input: Resources used intermediation, operational expenses for intermediation, total deposits
						Output: Total loans and bank's income
						Approach: Intermediation
Bhattacharyya & Pal (2013)	India	1989–2009	SFA	Technical efficiency	Positive impact of deregulation on technical efficiency of Indian banking sector at the initial phase of the reforms and negative impact on	**Environmental Variables:** Capital adequacy ratio and number of branches
						Inputs: Labour, capital and deposits
						Outputs: Loans, advances and investments
						Approach: Intermediation

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
					efficiency at the later phases.	
Berger & Hannan (1998)	US	1980–1989	SFA	Cost efficiency	Banks operating in more concentrated market environment recorded low cost efficiency.	**Environmental Variables:** Bank concentrations, Stocks owned by board members, share of outside owners, limitations for branching and population density **Inputs:** Labour and fixed assets **Outputs:** Deposits & loans **Approach:** Production
Girardone et al. (2004)	Italy	1993–1996	SFA and logistic regression	Cost efficiency	Risk and asset quality factors are very important in determining the scale efficiency of the Italian banking system. Capital strength positively related to the efficiency while non-performing loans showed negative relationship.	**Environmental Variables:** Assets, interest margins, branches, non-performing loans, capital and ownership **Inputs:** Labour and fixed assets **Outputs:** Loans and other earning assets **Approach:** Intermediation
Chang & Chiu (2006)	Taiwan	1996–2000	DEA and Tobit Regression	Cost efficiency	Cost efficiency is declined with NPL and VaR (value at risk). Further, capital	**Environmental Variables:** Capital adequacy, total loans, ROA, loan structure, number of branches, conglomeration and ownership

Author	Country /Region	Years	Method	Main Focus	Main Findings	Environmental Variables/Inputs & Outputs of main efficiency model(s)
					adequacy, total loans to total asset ratios, and conglomeration are also important determinants of efficiency.	**Inputs:** Number of bank employees, assets and deposits **Outputs:** Loan services & portfolio investments **Undesirable outputs:** Value at risk (VaR) & NPL **Approach:** Intermediation
Pasiouras et al. (2009)		2000–2004	DEA and Tobit regression	Technical efficiency	Inclusion of loss-loans as an input increase the efficiency level of the banks while off-balance sheet items do not have significant influence on efficiency.	**Environmental Variables:** Equity to assets, ROA, loans, and market power, no. of ATMs, no. of branches, foreign branches and subsidiaries. **Inputs:** Fixed assets, deposits and no. of employees, loss provisions **Outputs:** Loans, other earnings and off-balance sheet items **Approach:** Intermediation **Inputs:** Fixed assets, deposits and no. of employees, loss provisions **Outputs:** Loans, Interest income, non-interest income and off-balance sheet items **Approach:** Intermediation

APPENDIX C

a) Algorithms for computation and comparison of bootstrap weighted aggregate efficiency scores for heterogeneous sub-samples.

Step 1: Obtain DEA-based individual technical efficiency score $\{TE(x^k, y^k) : k = 1, ..., n\}$ from equation (4.21) in Chapter 4 for the sample $\Omega_n = \{(x^k, y^k) : k = 1, ..., n\}$.

Step 2: Aggregate the individual efficiencies derived from Step 1 into L subgroups using Equations (4.22) and (4.23) in Chapter 4 as $\overline{TE}^l$.

Step 3: Bootstrap sequence $\Omega^*_{s_{l,b}} = \{(x_b^{*k}, y_b^{*k}) : k = 1, ..., s_l\}$ for group l is obtained from bootstrap iteration b $(b = 1, ..., B)$, by sub-sampling with replacement independently, from the items in each subgroup l of the original sample $\Omega_{n_l} := \{(x^k, y^k) : k = 1, ..., n_l\}$ where $s_l \equiv (n_l)^k, k < 1, l = 1, ..., L.$

Step 4: Based on the bootstrap samples in Step 3, compile the DEA efficiency scores $TE_{VRS}^k \{x, y\}$ based on equation (4.10) for each bootstrap sample $\Omega^*_{n,b}$ where $k = 1, ..., s_l < n_l$ for all $l = 1, ..., L$.

Step 5: The bootstrap estimates of the weighted aggregate efficiency $\overline{TE_b^*}^l$ for group l are computed using the weights based on $S_b^{*l,k}$ given below:

$$\overline{TE_b^*}^l \equiv \sum_{k=1}^{s_l} TE_b^{*l,k} . S_b^{*l,k} \text{ where } S_b^{*l,k} = p y_b^{*l,k} / p \sum_{k=1}^{s_l} y_b^{*l,k}, k = 1, ..., s_l < n_l . \quad \text{(A.1)}$$

Similarly, bootstrap estimates of the weighted aggregate efficiency $\overline{TE_b^*}^l$ for the entire sample (all the sub-samples) is computed using:

$$\overline{TE_b^*} \equiv \sum_{l=1}^{L} \overline{TE_b^*}^l . S_b^{*l} \text{ where } S_b^{*l} = p \sum_{k=1}^{s_l} y_b^{*l,k} / p \sum_{l=1}^{L} \sum_{k=1}^{s_l} y_b^{*l,k}, l = 1, ..., L. \quad \text{(A.2)}$$

When the price-independent weights need to be calculated due to unavailability of price information, S_b^{*l} and $S_b^{*l,k}$ are derived as follows:

$$S_b^{*l} = 1/M \sum_{m=1}^{M} \left\{ \sum_{k=1}^{s_l} y_{m,b}^{*l.k} \Big/ \sum_{l=1}^{L} \sum_{k=1}^{s_l} y_{m,b}^{*l.k} \right\}, l = 1, ..., L.$$

$$S_b^{*l.k} = 1/M \left[\sum_{m=1}^{M} y_m^{l.k} \Big/ \sum_{k=1}^{s_l} y_{m,b}^{*l.k} S_b^{*l} \right], k = 1, ..., s_l < n_l, l = 1, ..., L.$$

Step 6: Obtain the bootstrap estimates by repeating Step 3 to Step 5, B times.

This process provides the B bootstrap aggregate efficiency estimates for subgroup l, $\left\{ \overline{TE_b}^{*l} \right\}_{b=l}^{B}$ and for the entire sample $\left\{ \overline{TE_b}^{*} \right\}_{b=l}^{B}$. The bias-corrected aggregate efficiency scores, the bootstrap confidence intervals for those bias-corrected efficiency scores and standard errors can be derived from the B bootstrap samples.

Comparison of aggregate efficiency between two groups

True bias in aggregate efficiency scores is given by:

$$Bias(\overline{TE}^l) \equiv E(\overline{TE}^l) - \overline{TE}^l. \tag{A.3}$$

This true bias can be approximated by using the group-wise aggregate efficiency scores estimated in step 2 and their bootstrap estimates in step 5 as follows:

$$Bias(\overline{TE^*}^l) \equiv E(\overline{TE^*})^l - \overline{TE}^l = \overline{\overline{TE_b^*}}^l - \overline{TE}^l \tag{A.4}$$

where $E(\overline{TE^*})^l$ can be estimated using its bootstrap analogue $\overline{\overline{TE_b^*}}^l$:

$$\overline{\overline{TE_b^*}}^l = \frac{1}{B} \sum_{b=1}^{B} \overline{TE_b^*}^l \tag{A.5}$$

Accordingly, the bias-corrected aggregate efficiency score $\overline{TE}^l$ is:

$$\overline{TE}^l = \overline{TE}^l - Bias(\overline{TE^*})^l = 2\overline{TE}^l - \overline{\overline{TE_b^*}}^l. \tag{A.6}$$

The computation of confidence intervals for the bias-corrected efficiency scores has two steps. First, sort the list of biases $\{ \overline{TE}^{*l} - \overline{TE}^l \}$ in ascending order. Second, truncate B number of observations by deleting $100(\alpha/2)\%$ of elements from left end and right end when the significant level is $\alpha\%$. If the first and last elements of the truncated list are $-a_\alpha$ and $-b_\alpha$ respectively, the bootstrap analogue for the true confidence interval can be derived from the following expression:

$$P \left[-b_\alpha \leq \overline{TE}^{*l} - \overline{TE}^l \leq -a_\alpha) \right] = 1 - \alpha \tag{A.7}$$

Accordingly, the bootstrap confidence interval for the true aggregate efficiency $\overline{\overline{TE}}^{l}$ for the group l is given by the expression $\overline{\overline{TE}}^{l} + a_{\alpha} \leq \overline{\overline{TE}}^{l} \leq \overline{\overline{TE}}^{l} + b_{\alpha}$.

The bootstrap estimate of the standard error of aggregate efficiency $\overline{\overline{TE}}^{l}$ can be computed as:

$$SE(\overline{\overline{TE}}_{b}^{*l}) \equiv \frac{1}{B-1}\left[\sum_{b=1}^{B}\left(\overline{\overline{TE}}_{b}^{*l} - \overline{\overline{TE}}^{l}\right)^{2}\right]^{1/2} \tag{A.8}$$

In addition to the comparison of aggregate-efficiencies between two groups based on bootstrap confidence intervals, Simar and Zelenyuk (2007) introduced a bootstrap-based test (*RD* test) to evaluate the equality of aggregate efficiency scores between two groups (groups A and Z). In this test null and alternative hypotheses are postulated as:

$H_{0}: \overline{\overline{TE}}^{A} = \overline{\overline{TE}}^{Z}$ against $H_{1}: \overline{\overline{TE}}^{A} \neq \overline{\overline{TE}}^{Z}$

where $\overline{\overline{TE}}^{A}$ and $\overline{\overline{TE}}^{Z}$ are the aggregate-efficiencies of the groups A and Z respectively.

The ratio of the technical efficiency of group A to that of group Z ($RD_{A,Z}$) is defined as

$RD_{A,Z} = \overline{\overline{TE}}^{A} / \overline{\overline{TE}}^{Z}$.

A series of $RD_{A,Z,b}^{*}$s can be derived using the bootstrap aggregate efficiency scores computed previously to generate the confidence interval for $\overline{\overline{TE}}^{l}$ as:

$$RD_{A,Z,b}^{*} = \frac{\overline{\overline{TE}}_{b}^{*A}}{\overline{\overline{TE}}_{b}^{*Z}} \text{ where } b=1,...B \tag{A.9}$$

The series of $RD_{A,Z,b}^{*}$ is sorted in ascending order and truncated by deleting $100(\alpha/2)\%$ of elements at the beginning and end of the series when the level of significance is $\alpha\%$. The lower bound and upper bound of the confidence interval of $RD_{A,Z}$ are the first element and last element of the sorted series respectively. The outcome of the hypothesis test is based on the confidence interval of $RD_{A,Z}$. If the interval of $RD_{A,Z}$ does not include unity (or 1), H_{0} is rejected, and otherwise it is not rejected.

b) Li test for comparing the equality of two efficiency densities

Suppose $f_{A}(m^{A})$ and $f_{Z}(m^{Z})$ are two probability density functions with distribution functions $F_{A}(.)$ and $F_{Z}(.)$ representing two subgroups A and Z from a population. The distribution functions are absolutely continuous with respect to the Lebesgue measures in $\Re^{p}$. Two random

samples, $\left\{m^{A,i} : i = 1,...,n_A\right\}$ and $\left\{m^{Z,i} : i = 1,...,n_Z\right\}$, belong to two subgroups A and Z. The null and alternative hypotheses for comparing densities are defined as follows:

$$H_o : f_A(m^A) = f_Z(m^Z)$$

$$H_1 : f_A(m^A) \neq f_Z(m^Z) \text{ on a set of positive measures.}$$

The integrated square differences (I_{ISD}) criterion is adapted by Li (1996) to test these hypotheses:

$$I_{ISD} = \int (f_A(m) - f_Z(m))^2 \, dt = \int (f_A^2(m) - f_Z^2(m) - 2f_A(m)f_Z(m)) \, dm$$

$$= \int (f_A(m).dF_A(m)) + \int (f_Z(m).dF_Z(m)) - \int (f_A(m).dF_Z(m)) - \int (f_Z(m).dF_A(m)) \quad \text{(B.1)}$$

According to Li (1996), this satisfies the property $I_{ISD} \geq 0$ and $I_{ISD} = 0$ if and only if H_0 is true.

The test statistic I_{ISD} is estimated by (I_{ISD}), replacing unknown distribution functions $F_{A(.)}$ and $F_{Z(.)}$ by empirical distribution functions $F_{An_A}(.)$ and $F_{Zn_Z}(.)$ while the unknown densities $f_{An_A}(.)$ and $f_{Zn_Z}(.)$ are replaced by the kernel density estimates $f_{An_A}(.)$ and $f_{Zn_Z}(.)$ where:

$$F_{l,n_l}(m) = \frac{1}{n_l}\sum_{k=1}^{n_l} I\left(m^{l,k} \leq m\right), \ l = A, Z \text{ and} \quad \text{(B.2)}$$

$$f_{l,n_l}(m) = \frac{1}{h_l n_l}\sum_{k=1}^{n_l} K\left(\frac{m - m^{l,k}}{h_l}\right), \ l = A, Z. \quad \text{(B.3)}$$

I in equation (B.2) is an indicator function and $I = 1$ if the expression $\left(m^{l,k} \leq m\right)$ is true and zero otherwise, while $h_l = h(n_l)$ is a bandwidth when $h_l \to 0$, $h_l n_l \to \infty$, since $n_l \to \infty$. In equation (B.3), K is a kernel function and density is estimated at m. Considering m as the observed point, $h = \min(h_A, h_Z)$ and removing the diagonal term $(k \neq j)$, the test statistic $(I_{ISD})_{n_A n_Z h}$ is defined as follows:

$$(I_{ISD})_{n_A n_Z h} = \left\{ \begin{array}{l} \dfrac{1}{(hn_A^2 - hn_A)}\sum_{i=1}^{n_A}\sum_{k=1,k\neq j}^{n_A} K\left(\dfrac{m^{A,i} - m^{A,k}}{h}\right) + \dfrac{1}{(hn_Z^2 - hn_Z)}\sum_{j=1}^{n_Z}\sum_{k=1,k\neq j}^{n_Z} K\left(\dfrac{m^{Z,j} - m^{Z,k}}{h}\right) \\[4mm] + \dfrac{1}{(hn_A n_Z - hn_A)}\sum_{i=1}^{n_Z}\sum_{k=1,k\neq j}^{n_A} K\left(\dfrac{m^{Z,j} - m^{A,k}}{h}\right) + \dfrac{1}{(hn_Z n_A - hn_Z)}\sum_{j=1}^{n_A}\sum_{k=1,k\neq j}^{n_Z} K\left(\dfrac{m^{A,j} - m^{Z,k}}{h}\right) \end{array} \right\}$$

$$\text{(B.4)}$$

Assuming that f_A and f_Z are continuous and bounded in $\Re$, Li (1996) proved that the limiting distribution of (B.4) can be standardised into $J^{nd}_{n_A,n_{Z,h}}$ which follows the standard normal distribution, i.e. $J^{nd}_{n_A,n_{Z,h}}$ is asymptotically normal.

$$J^{nd}_{n_A,n_{Z,h}} = \frac{n_A h^{1/2}(I_{ISD})_{n_A n_Z h}}{\sigma_{\lambda h}^2} \overset{(H_o true)}{\square} N(0,1) \text{ where:} \tag{B.5}$$

$$\sigma^2_{\lambda h} := 2 \left[\begin{array}{c} \dfrac{1}{h n_A^2}\sum_{j=1}^{n_A}\sum_{k=1}^{n_A} K\left(\dfrac{m^{A,j}-m^{A,k}}{h}\right) + \dfrac{\lambda_n^2}{h n_Z^2}\sum_{j=1}^{n_Z}\sum_{k=1}^{n_Z} K\left(\dfrac{m^{Z,j}-m^{Z,k}}{h}\right) - \\[2mm] \dfrac{\lambda_n}{h n_A n_Z}\sum_{i=1}^{n_Z}\sum_{k=1}^{n_A} K\left(\dfrac{m^{Z,j}-m^{A,k}}{h}\right) - \dfrac{\lambda_n}{h n_Z n_A}\sum_{j=1}^{n_A}\sum_{k=1}^{n_Z} K\left(\dfrac{m^{A,j}-m^{Z,k}}{h}\right) \end{array}\right] \cdot \left[\int K^2(m)dm\right]$$

assuming $\lambda_n = n_A / n_Z$ and $\lambda_n \to \lambda$ when $n_A \to \infty$ where $\lambda \in (0,\infty)$ is a constant.

In the context of comparing the efficiency of heterogeneous sub-samples, technical efficiency scores in each sub-sample, $\{TE^{A,k} : k=1,...,n_A\}$ and $\{TE^{Z,k} : k=1,...,n_z\}$ are assumed to be distributed independently and identically (iid) with density functions $f_A(.)$ and $f_Z(.)$ respectively. Although the true efficiency scores are iid, this study compares the two groups of estimated efficiency scores calculated based on DEA which are downward-biased and not independent (Simar & Wilson 1998). Simar and Zelenyuk (2006) followed the bootstrap procedures introduced by Li (1999) based on resampling to derive more consistent estimates. The consistent estimate for p-value ($\hat{p}$) of the Li test based on bootstrap samples is given by:

$$\hat{p} = \frac{1}{B}\sum_{b=1}^{B} I(J^{nd,b}_{n_A,n_Z} > J^{nd}_{n_A,n_Z}), \tag{B.6}$$

where $J^{nd,b}_{n_A,n_Z}$ is a consistent bootstrap analogue of the Li test statistics $J^{nd}_{n_A,n_Z}$ given in (B.5) and indicator function I equals one when $(J^{nd,b}_{n_A,n_Z} > J^{nd}_{n_A,n_Z})$ is true, and zero otherwise, while B is the number of bootstrap samples used. In this study $B=2000$ since it uses 2000 bootstrap samples.

APPENDIX D

Table D.1: Determinants of efficiency based on double-bootstrap regression models under the intermediation approach (FULL model).

Environmental Variable	Coefficient	Confidence Intervals					
		Lower Bounds			Upper Bounds		
		1%	5%	10%	1%	5%	10%
Constant	14.497	11.449	12.336	12.735	17.273	16.764	16.515
COVER	-0.105	-0.624	-0.446	-0.386	0.348	0.227	0.197
EXP	-0.115	-0.401	-0.335	-0.298	0.372	0.235	0.171
CAP	-2.825	-3.943	-3.631	-3.551	-1.723	-1.997	-2.148
NPA	-1.079	-2.330	-2.023	-1.876	0.224	-0.056	-0.271
LOASSETS	-1.306	-2.032	-1.875	-1.817	-0.502	-0.646	-0.783
GDPG	0.051	-0.039	-0.019	-0.010	0.133	0.119	0.112
SIZE	-0.720	-0.874	-0.848	-0.838	-0.538	-0.595	-0.614
ROA	-1.740	-7.279	-6.158	-5.329	4.293	2.546	1.841
OWN	0.150	-0.253	-0.136	-0.094	0.501	0.417	0.385
TREND	-0.032	-0.086	-0.068	-0.062	0.028	0.008	0.000

Note: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.2: Determinants of efficiency based on double-bootstrap regression models under the operating approach (FULL model).

Environmental Variable	Coefficient	Confidence Intervals					
		Lower Bounds			Upper Bounds		
		1%	5%	10%	1%	5%	10%
Constant	9.333	7.929	8.326	8.544	10.679	10.383	10.253
COVER	-0.174	-0.445	-0.368	-0.336	0.054	-0.009	-0.036
EXP	-0.055	-0.161	-0.121	-0.100	0.203	0.153	0.117
CAP	-0.975	-1.619	-1.446	-1.372	-0.334	-0.487	-0.579
NPA	-1.260	-1.936	-1.780	-1.702	-0.506	-0.666	-0.775
LOASSETS	-0.509	-0.921	-0.820	-0.776	-0.103	-0.201	-0.248
GDPG	0.038	-0.015	-0.004	0.004	0.083	0.074	0.068
SIZE	-0.432	-0.513	-0.492	-0.484	-0.354	-0.376	-0.387
ROA	-10.746	-14.365	-13.502	-13.077	-7.159	-8.125	-8.565
OWN	0.345	0.138	0.185	0.212	0.532	0.491	0.467
TREND	-0.020	-0.045	-0.037	-0.034	0.010	0.002	-0.002

Note: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.3: Determinants of efficiency based on double-bootstrap regression models under the intermediation approach (COM model).

| Environmental Variable | Coefficient | Confidence Intervals | | | | | |
| | | Lower Bounds | | | Upper Bounds | | |
		1%	5%	10%	1%	5%	10%
Constant	12.783	7.964	9.813	10.393	17.113	16.586	15.955
COVER	0.029	-0.546	-0.476	-0.380	0.656	0.519	0.456
EXP	-0.612	-1.320	-1.173	-1.100	0.283	0.031	-0.119
CAP	-1.594	-3.122	-2.912	-2.677	-0.183	-0.374	-0.603
NPA	-2.675	-5.322	-4.751	-4.430	0.824	-0.069	-0.742
LOASSETS	-1.051	-2.050	-1.773	-1.687	0.001	-0.289	-0.422
GDPG	0.123	-0.033	0.009	0.038	0.226	0.208	0.198
SIZE	-0.666	-0.933	-0.891	-0.859	-0.374	-0.479	-0.516
ROA	-2.166	-10.367	-8.434	-7.415	7.492	3.852	3.130
OWN	0.269	-0.161	-0.065	-0.024	0.686	0.613	0.553
TREND	-0.060	-0.114	-0.106	-0.098	0.006	-0.015	-0.021

Note: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.4: Determinants of efficiency based on double-bootstrap regression models under the operating approach (COM model).

Environmental Variable	Coefficient	Confidence Intervals					
		Lower Bounds			Upper Bounds		
		1%	5%	10%	1%	5%	10%
Constant	5.210	4.346	4.585	4.710	6.096	5.855	5.762
COVER	-0.045	-0.224	-0.175	-0.152	0.136	0.092	0.064
EXP	-0.054	-0.265	-0.207	-0.187	0.182	0.114	0.080
CAP	0.500	0.064	0.158	0.211	0.994	0.862	0.803
NPA	-0.765	-1.541	-1.381	-1.275	0.064	-0.128	-0.230
LOASSETS	-0.634	-0.988	-0.908	-0.867	-0.275	-0.367	-0.408
GDPG	0.036	-0.001	0.009	0.013	0.071	0.062	0.058
SIZE	-0.201	-0.248	-0.238	-0.231	-0.152	-0.164	-0.172
ROA	-11.475	-14.515	-13.872	-13.583	-8.696	-9.236	-9.551
OWN	0.449	0.301	0.332	0.353	0.595	0.562	0.545
TREND	-0.029	-0.047	-0.043	-0.041	-0.011	-0.015	-0.018

Note: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.5: Determinants of efficiency based on double-bootstrap regression models under the intermediation approach (COM-GOV model).

Environmental Variable	Coefficient	Confidence Intervals					
		Lower Bounds			Upper Bounds		
		1%	5%	10%	1%	5%	10%
Constant	12.266	7.815	9.022	9.832	16.772	15.976	15.476
COVER	0.072	-0.591	-0.438	-0.374	0.732	0.578	0.499
EXP	-0.671	-1.420	-1.277	-1.187	0.426	0.193	-0.016
CAP	-1.587	-3.121	-2.868	-2.660	0.000	-0.438	-0.618
NPA	-2.448	-5.119	-4.376	-4.114	1.261	-0.369	-0.735
LOASSETS	-1.056	-2.107	-1.839	-1.760	0.011	-0.224	-0.346
GDPG	0.134	0.002	0.036	0.057	0.241	0.221	0.212
SIZE	-0.642	-0.917	-0.859	-0.834	-0.365	-0.448	-0.499
ROA	-1.741	-9.718	-7.641	-6.654	7.018	4.461	3.604
OWN	0.266	-0.218	-0.097	-0.041	0.730	0.589	0.545
TREND	-0.062	-0.125	-0.110	-0.103	0.003	-0.014	-0.023

Note: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.6: Determinants of efficiency based on double-bootstrap regression models under the operating approach (COM-GOV model).

| Environmental Variable | Coefficient | Confidence Intervals | | | | | |
| | | Lower Bounds | | | Upper Bounds | | |
		1%	5%	10%	1%	5%	10%
Constant	5.038	3.887	4.303	4.428	6.113	5.839	5.714
COVER	-0.025	-0.205	-0.157	-0.129	0.176	0.127	0.092
EXP	-0.068	-0.318	-0.257	-0.220	0.197	0.116	0.085
CAP	0.505	0.045	0.147	0.203	1.025	0.882	0.811
NPA	-0.786	-1.509	-1.403	-1.298	0.130	-0.109	-0.250
LOASSETS	-0.644	-1.042	-0.927	-0.881	-0.284	-0.356	-0.403
GDPG	0.045	0.005	0.016	0.022	0.082	0.072	0.069
SIZE	-0.193	-0.256	-0.239	-0.228	-0.128	-0.149	-0.156
ROA	-11.515	-15.160	-14.130	-13.771	-8.551	-9.284	-9.517
OWN	0.451	0.286	0.333	0.361	0.597	0.565	0.551
TREND	-0.034	-0.053	-0.049	-0.046	-0.014	-0.019	-0.022

Note: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.7: Determinants of efficiency of Sri Lankan banks based on technical inefficiency models of Battese and Coeli (1995)

Environmental Variable	Intermediation approach			Operating approach		
	FULL Model	COM Model	COM-GOV Model	FULL Model	COM Model	COM-GOV Model
Constant	19.50***	20.3122***	19.7981***	7.5146***	4.6250***	4.4388
COVER	0.0612	0.0352	0.0849	-0.0315	-0.0312	-0.0599
EXP	0.0191	-0.0678	-0.0947	-0.0264	-0.0252	-0.0377
CAP	-0.2897***	-0.2243	-0.2197	-0.4528***	-0.3777***	-0.4263***
NPA	-0.0976	-0.2718	-0.2403	-0.2673***	-0.3921***	-0.3149**
LOASSETS	-0.7973***	-0.8941***	-0.8879***	-0.1113*	-0.1536**	-0.1006
GDPG	0.0212**	0.0226***	0.0246***	0.0268***	0.0143*	0.0170**
SIZE	-0.9894***	-0.9730***	-0.9718***	-0.3672***	-0.2265***	-0.2243***
ROA	-0.5540	-0.4143	-0.4139	-2.0247***	-3.7977***	-3.7471***
OWN	-0.0969**	0.0035	-0.0062	-0.0188	0.0832***	0.1123**
TREND	-0.0031	-0.0044	-0.0048	0.0003	-0.0099***	-0.0130***

Notes: COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.8: Determinants of efficiency of Sri Lankan banks based on double-bootstrap regression models under the intermediation approach.

Explanatory Variable	Intermediation approach					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	14.4973***	14.3441***	14.4963***	14.6867***	14.4566***	14.4823***
COVER	-0.1048		-0.1187	-0.1536	-0.1159	-0.1316
EXP	-0.1146	-0.1158		-0.0099	-0.1162	-0.0614
CAP	-2.8251***	-2.9209***	-2.9423***	-2.8224***	-2.9719***	-3.0599***
NPA	-1.0785**	-1.0692**	-1.0111*	-1.0493**	-1.0718**	-0.9459**
LOASSETS	-1.3059***	-1.3776***	-1.3320***	-1.3540***	-1.3684***	-1.2555***
GDPG	0.0510	0.0507	0.0508		0.0561	0.0522*
SIZE	-0.7196***	-0.7081***	-0.7183***	-0.7082***	-0.7203***	-0.7135***
ROA	-1.7396	-1.6113	-1.3735	-2.2787		-2.3612
OWN	0.1500	0.1168	0.1211	0.1322	0.1705	
TREND	-0.0322*	-0.0328*	-0.0277	-0.0266	-0.0272	-0.0255

Notes: (1) Coefficients with ***, ** and * indicate statistical significance from zero at the 1%, 5% and 10% levels, respectively; (2) COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.9: Determinants of efficiency of Sri Lankan banks based on double-bootstrap regression models under the operating approach

Explanatory Variable	Operating approach	
	Model 1	Model 2
Constant	9.3332***	9.3159***
COVER	-0.1739**	-0.1832**
EXP	-0.0547	
CAP	-0.9752***	-0.9792***
NPA	-1.2595***	-1.2925***
LOASSETS	-0.5085***	-0.4930***
GDPG	0.0378*	0.0357**
SIZE	-0.4316***	-0.4296***
ROA	-10.7459***	-11.0349***
OWN	0.3448***	0.3393***
TREND	-0.0195*	-0.0200**

Notes: (1) Coefficients with ***, ** and * indicate statistical significance from zero at the 1%, 5% and 10% levels, respectively; (2) COVER is the percentage of bank branches outside the Western region; EXP is the annual growth in number of bank branches; CAP is the ratio of equity to total assets; NPA is the ratio of non-performing advances to total advances; LOASSETS is the ratio of total loans to total assets; GDPG is the annual real growth in GDP; SIZE is the natural logarithm of total assets; ROA is the ratio of profit before tax to total assets of the bank; OWN is the dummy variable for foreign ownership; TREND is a time trend.

Source: Author's calculations

Table D.10: Changes in productivity levels based on Malmquist productivity index (2006–2014) – Intermediation approach

		2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2006-09	2010-14	2006-14
Domestic commercial banks	ΔTFP	1.055	0.973	1.030	1.005	1.049	1.044	1.073	1.015	1.019	1.037	1.030
	ΔEFF	1.055	0.917	1.048	0.990	1.059	0.996	0.975	1.003	1.005	1.004	1.004
	ΔTEC	1.000	1.061	0.984	1.015	0.990	1.049	1.113	1.012	1.014	1.035	1.027
Domestic specialised banks	ΔTFP	0.872	1.032	0.993	1.002	0.909	0.996	0.919	1.028	0.963	0.970	0.967
	ΔEFF	0.958	0.954	1.080	0.987	1.033	0.987	0.989	1.010	0.996	1.001	0.999
	ΔTEC	0.910	1.081	0.919	1.015	0.880	1.009	0.929	1.018	0.967	0.969	0.968
Foreign banks	ΔTFP	1.069	1.031	1.074	0.966	0.942	1.058	1.068	1.065	1.058	1.018	1.033
	ΔEFF	1.038	0.953	1.049	0.969	1.025	0.994	1.013	1.000	1.013	1.000	1.005
	ΔTEC	1.030	1.082	1.024	0.996	0.919	1.065	1.055	1.065	1.045	1.018	1.028
All banks	ΔTFP	1.012	1.005	1.035	0.991	0.979	1.037	1.032	1.034	1.017	1.014	1.016
	ΔEFF	1.026	0.938	1.056	0.983	1.042	0.993	0.990	1.004	1.005	1.002	1.003
	ΔTEC	0.987	1.072	0.980	1.009	0.940	1.044	1.047	1.030	1.012	1.013	1.013

Note: ΔTFP denotes productivity change; ΔTFP > 1 and ΔTFP < 1 indicate positive and negative TFP changes, respectively. ΔEFF represents technical efficiency change; ΔEFF > 1 and ΔEFF < 1 show an improvement or decline in technical efficiency, respectively. ΔTEC is the technical-change component, which measures how much the frontier shifts. It can be > 1 when the technical change is positive or < 1 when it is negative.

Source: Author's calculations

Table D.11: Changes in productivity levels based on Malmquist productivity index (2006–2014) – Operating approach

		2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	22012/13	2013/14	2006-09	2010-14	2006-14
Domestic commercial banks	ΔTFP	0.922	1.047	1.052	1.010	0.997	1.057	1.103	0.919	1.005	1.015	1.012
	ΔEFF	0.953	1.029	1.031	0.981	1.020	0.913	1.023	1.063	1.004	0.999	1.000
	ΔTEC	0.968	1.018	1.020	1.030	0.977	1.157	1.078	0.865	1.002	1.017	1.011
Domestic specialised banks	ΔTFP	0.936	1.031	1.067	1.186	0.840	0.931	1.049	1.005	1.010	0.995	1.001
	ΔEFF	0.897	0.974	1.043	1.058	0.995	0.889	0.999	1.109	0.970	1.007	0.993
	ΔTEC	1.044	1.058	1.023	1.182	0.829	1.047	1.049	0.906	1.042	0.995	1.012
Foreign banks	ΔTFP	0.975	1.044	1.018	1.027	0.919	1.194	1.088	0.957	1.012	1.033	1.025
	ΔEFF	1.052	0.978	1.008	0.981	1.020	1.049	0.994	0.995	1.012	1.007	1.009
	ΔTEC	0.927	1.047	1.025	1.048	0.901	1.138	1.095	0.951	0.998	1.023	1.013
All banks	ΔTFP	0.942	1.042	1.045	1.056	0.932	1.066	1.085	0.951	1.009	1.016	1.013
	ΔEFF	0.969	0.999	1.027	0.999	1.014	0.948	1.008	1.051	0.998	1.003	1.001
	ΔTEC	0.972	1.037	1.023	1.071	0.915	1.124	1.077	0.902	1.010	1.013	1.012

Note: ΔTFP denotes productivity change; ΔTFP > 1 and ΔTFP < 1 indicates positive and negative TFP changes, respectively. ΔEFF represents technical efficiency change; ΔEFF > 1 and ΔEFF < 1 show an improvement or decline in technical efficiency, respectively. ΔTEC is the technical-change component, which measures how much the frontier shifts. It can be >1 when the technical change is positive or <1 when it is negative.

Source: Author's calculations

APPENDIX E

Table E.1: Determinants of efficiency of Sri Lankan banks at the regional level based on Model 1(V).

| Variable | Coefficient | Confidence Intervals | | | | | |
| | | Lower Bounds | | | Upper Bounds | | |
		1%	5%	10%	1%	5%	10%
Constant	19.589	-36.047	-11.285	-7.134	60.331	51.230	46.347
GDPPL	0.587	-6.526	-4.676	-3.778	7.741	5.656	4.780
DENSIL	-2.353	-4.317	-4.056	-3.759	0.035	-0.535	-0.837
DDENL	-1.368	-4.393	-3.767	-3.440	2.377	1.143	0.519
UNEMP	0.422	-0.440	-0.201	-0.060	1.147	1.081	0.961
EDU	0.268	-0.693	-0.247	-0.175	0.988	0.805	0.735
BTYPE	-4.156	-5.724	-5.476	-5.272	-1.973	-2.820	-3.163
REG	-0.023	-0.369	-0.297	-0.247	0.335	0.262	0.204
TIME	-0.055	-1.336	-0.897	-0.701	1.008	0.686	0.588

Note: GDPPL is the logarithm of regional per capita GDP; DENSIL is the logarithm of population density; DDENL is the logarithm of deposit density; UNEMP is the regional unemployment rate; EDU is the percentage of the population with secondary level education in the region; BTYPE is a dummy variable for commercial and specialised banks; REG is a dummy variable for nine regions; TIME is a dummy variable for time trend.

Source: Author's calculations

Table E.2: Determinants of efficiency of Sri Lankan banks at the regional level based on Model 2(N).

| Variable | Coefficient | Confidence Intervals | | | | | |
| | | Lower Bounds | | | Upper Bounds | | |
		1%	5%	10%	1%	5%	10%
Constant	-2.972	-9.866	-4.461	-3.632	2.423	-0.779	-2.079
GDPPL	-1.756	-3.938	-2.403	-2.029	-0.854	-1.238	-1.477
DENSIL	0.255	-0.272	0.031	0.163	0.820	0.385	0.330
DDENL	-2.188	-3.113	-2.573	-2.343	-1.216	-1.889	-2.044
UNEMP	1.052	0.213	0.589	0.739	2.345	1.692	1.467
EDU	0.150	-0.074	0.041	0.093	0.294	0.233	0.183
BTYPE	14.613	11.614	12.670	13.336	20.178	16.866	16.138
REG	-0.046	-0.651	-0.246	-0.099	0.452	0.137	0.045
TIME	0.663	0.279	0.507	0.598	1.103	0.837	0.786

Note: GDPPL is the logarithm of regional per capita GDP; DENSIL is the logarithm of population density; DDENL is the logarithm of deposit density; UNEMP is the regional unemployment rate; EDU is the percentage of the population with secondary level education in the region; BTYPE is a dummy variable for commercial and specialised banks; REG is a dummy variable for nine regions; TIME is a dummy variable for time trend.

Source: Author's calculations

Table E.3: Determinants of efficiency of Sri Lankan banks at the regional level based on the technical inefficiency model of Battese and Coelli (1995)

Variable	Model 1(V)	Model 2(N)
Constant	-0.1689	-7.6381***
GDPPL	0.5128	-1.1851***
DENSIL	-0.2289**	0.2465**
DDENL	-0.0411	-0.3228**
UNEMP	0.0416	-0.0015
EDU	-0.0171	0.0029
BTYPE	-0.3958***	1.0140***
REG	0.0148	0.0075
TIME	-0.0347	-0.1148**

Note: (1) Coefficients with ***and ** indicate statistical significance from zero at the 1% and 5% levels, respectively; (2) GDPPL is the logarithm of regional per capita GDP; DENSIL is the logarithm of population density; DDENL is the logarithm of deposit density; UNEMP is the regional unemployment rate; EDU is the percentage of the population with secondary level education in the region; BTYPE is a dummy variable for commercial and specialised banks; REG is a dummy variable for nine regions; TIME is a dummy variable for time trend.

Source: Author's calculations

APPENDIX F

Section F.1

Changes in banking efficiency before and after the end of the conflict

Intermediation and operating efficiency between the two periods 2006–2009 and 2010–2014 are also evaluated excluding the specialised banks. As in section 5.3, the Li test and the aggregate efficiency techniques are employed for this comparison. Further, the technology gap between these two periods for commercial banks are also evaluated using the meta-frontier framework of O'Donnell *et al*. (2008).

Table F.1.1 : Comparison of banking efficiency before and after the end of the conflict based on the Li test

	Li Test Statistic	*P*-value	Decision on *Ho* (at 5% sig. level)
Intermediation approach			
f1(2010–2014) = f1(2006–2009)	1.3916**	0.0320	Reject *Ho*
Operating approach			
f1(Year 2010–2014) = f1(Year 2006–2009)	0.3444	0.6730	*Do not reject Ho*

Note: The Li Test Statistics with ** are significant at the 5% level.

Source: Author's calculations

Table F.1.2 : Comparison of banking efficiency before and after the end of the conflict based on RD statistics

Statistics	Bias-Corr. Estimates (RD-statistic)	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
RD_aggregate (2010–2014 vs 2006–2009)	0.878***	0.026	0.839	0.942
RD_mean (2010–2014 vs 2006–2009)	0.937	0.044	0.853	1.036
Operating approach				
RD_aggregate (2010–2014 vs 2006–2009)	0.868***	0.048	0.781	0.967
RD_mean (2010–2014 vs 2006–2009)	0.984	0.060	0.863	1.098

Note: The ratios of aggregate efficiency (RD_aggregate) and mean efficiency (RD_mean) with *** meaning significance at the 1% level.

Source: Author's calculations

Table F.1.3: MTRs of Sri Lankan banks before and after the end of the armed conflict

Period (Years)	Intermediation Approach		Operating Approach	
	Mean MTRs	Bootstrap Mean MTRs	Mean MTRs	Bootstrap Mean MTRs
2010–2014	0.9303	0.8960	0.9954	0.9992
2006–2009	0.8647	0.8105	0.8596	0.8168

Source: Author's calculations

As in Section 5.3 of the thesis, the Li-test reveals the significant differences between banking performance for the two periods 2006–2009 and 2010–2014 with respect to the intermediation approach. However significant differences have not been observed with respect to the operating approach. This could be due to less focus of commercial banks on profit maximization relative to intermediation with their expansion in the post-conflict era.

In line with the analysis presented in Section 5.3 for all bank groups, a significant improvement in banking performance in 2010–2014 relative to 2006–2009 is recorded based on the aggregate efficiency technique when the sample is limited to the commercial banks as presented in Table F.1.2. Further, improvement in the technology gap is also confirmed by the higher MTR ratios reported for the 2010-2014 period in Table F.1.3.

In general, most of the results in Section 5.3 are robust when the sample is restricted to the commercial banks in Sri Lanka with respect to both the intermediation approach and operating approach. This can be due to two reasons. First, commercial banks dominate the banking sector with a higher number of banks and branches. Second, commercial banks exploited economic expansion in the post conflict period by improving their intermediation and operating activities.

Section F.2
Bank groups and performance

Intermediation and operating efficiency between the domestic and foreign commercial banks are also evaluated. As in section 5.4, the Li test and the aggregate efficiency techniques are employed for this comparison. Further a meta-frontier framework of O'Donnell *et al*. (2008) is employed to evaluate the technology gap between these groups of commercial banks.

Table F.2.1: Comparison of efficiency between foreign and domestic commercial banks based on the Li test

H₀(f is kernel densities)	Li Test Statistic	*P*-value	Decision on Ho (at 5% sig. level)
Intermediation approach			
f1(Foreign) = f1(Domestic)	6.774***	0.000	Reject *Ho*
Operating approach			
f1(Foreign) = f1(Domestic)	8.327***	0.000	Reject *Ho*

Notes: The Li Test Statistics with *** are significant at the 1% level and ** when significant at the 5% level.

Source: Author's calculations

Table F.2.2: Efficiency comparison of bank groups by ownership based on RD statistics

Statistics	Bias-Corr. Estimates (RD-statistic)	Std. Error	95% Confidence Interval Bounds	
			Lower	Upper
Intermediation approach				
Foreign vs Domestic Commercial Banks				
RD_aggregate (Foreign /Domestic)	1.139***	0.026	1.191	1.061
RD_mean (Foreign/Domestic)	1.067***	0.044	1.172	0.966
Operating approach				
Foreign vs Domestic Commercial Banks				
RD_aggregate (Foreign /Domestic)	0.869***	0.039	0.937	0.817
RD_mean (Foreign /Domestic)	1.041	0.080	1.233	0.896

Note: The ratios of aggregate efficiency (RD_aggregate) and mean efficiency (RD_mean) with *** meaning significance at the 1% level.

Source: Author's calculations

Table F.2.3: MTRs of bank groups by ownership

Ownership	Intermediation Approach		Operating Approach	
	Mean MTRs	Bootstrap Mean MTRs	Mean MTRs	Bootstrap Mean MTRs
FCB	0.9785	0.9715	0.9907	0.9870
DCB	0.8654	0.8017	0.8402	0.8351

Note: FCB-Foreign Commercial Bank; DCB-Domestic Commercial Banks.

Source: Author's calculations

Li-test results presented in Table F.2.1 reveal the significant differences in banking performance between domestic and foreign commercial banks with respect to both the intermediation and operating approaches. Further, aggregate efficiencies derived for the domestic and foreign commercial bank groups in Table F.2.2 confirm higher intermediation efficiency among domestic commercial banks. However, as expected, operating efficiency is higher among the foreign commercial banks group. These findings are in line with

the findings presented in Section 5.4 of the thesis when the sample is comprised of both commercial and specialised banks. In addition, a higher technology set used in foreign commercial banks is also reflected by higher MTR ratios for them as presented in Table F.2.3. Accordingly, the difference between efficiency of the domestic and foreign commercial banks are more robust when the specialised banks are excluded from the sample.

Section F.3

Changes in banking sector productivity levels

In line with the productivity analysis presented in 5.6 for all the banks, Table F.3.1 & Table F.3.2 present the productivity changes in intermediation and operational processes in the banking sector in Sri Lanka only for commercial banks. The productivity changes for the period 2006–2014 are estimated using the DEA-based GMPI. The productivity changes based on the GMPI have also been disaggregated into two constituent components, namely efficiency change (ΔEFF) and frontier shift due to technology change (ΔTEC).

Productivity changes in intermediation services

Table F.3.1 presents the productivity changes with respect to the intermediation services for the period 2006–2014 when the sample is restricted to commercial banks. The results show an improvement in productivity during the reference period. Further, productivity changes are mainly due to the technological changes recorded in foreign banks. These findings are somewhat similar to the findings presented in Table 5.16 with respect to both commercial and specialised banks.

Productivity changes in operational services

Productivity changes in commercial banks with respect to operations for the period 2006–2014 are presented in Table F.3.2. The results revealed an increase in productivity during the reference period. The disaggregation of productivity changes shows that technical changes in the foreign banks were the major factor bringing about this progress. Therefore, significant differences in banking sector productivity changes with respect to the operational approach are not observed when the scope of the analysis is restricted to the commercial banks.

Table F.3.1: Changes in productivity levels based on the intermediation approach (2006–2014)

Bank Group		2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2006–09	2010–14	2006–14
Domestic banks	ΔTFP	1.062	0.973	1.021	0.992	1.033	1.041	1.026	0.998	1.018	1.018	1.018
	ΔEFF	1.020	0.942	1.034	1.010	1.016	0.997	0.980	1.023	0.998	1.005	1.002
	ΔTEC	1.042	1.032	0.988	0.982	1.016	1.045	1.047	0.975	1.020	1.013	1.016
Foreign banks	ΔTFP	1.158	1.013	1.116	0.924	0.925	1.081	1.068	0.972	1.094	0.992	1.029
	ΔEFF	1.022	0.963	1.038	0.992	1.009	0.988	1.012	1.000	1.007	1.000	1.003
	ΔTEC	1.133	1.052	1.075	0.932	0.917	1.094	1.055	0.972	1.086	0.992	1.026
All commercial banks	ΔTFP	1.102	0.990	1.060	0.963	0.986	1.058	1.043	0.987	1.049	1.007	1.022
	ΔEFF	1.020	0.951	1.035	1.002	1.013	0.993	0.994	1.013	1.002	1.003	1.002
	ΔTEC	1.079	1.040	1.024	0.961	0.973	1.065	1.050	0.974	1.048	1.004	1.020

Note: ΔTFP denotes productivity change; ΔTFP > 1 and ΔTFP < 1 indicate positive and negative TFP changes, respectively. ΔEFF represents technical efficiency change; ΔEFF > 1 and ΔEFF < 1 show an improvement or decline in technical efficiency, respectively. ΔTEC is the technical change component, which measures how much the frontier shifts. It can be > 1 when the technical change is positive and < 1 when it is negative.

Source: Author's calculations

Table F.3.2: Changes in productivity levels based on the operating approach (2006–2014)

Bank Group		2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2006–09	2010–14	2006–14
Domestic banks	ΔTFP	0.955	1.025	1.038	1.020	0.993	1.036	1.043	0.955	1.005	1.009	1.008
	ΔEFF	0.947	1.032	1.057	0.971	1.014	0.894	1.023	1.091	1.011	0.997	1.002
	ΔTEC	1.008	0.993	0.982	1.050	0.979	1.158	1.019	0.876	0.994	1.012	1.006
Foreign banks	ΔTFP	1.087	1.017	1.076	0.961	0.861	1.210	1.040	0.947	1.060	1.006	1.020
	ΔEFF	1.047	0.981	1.051	1.000	1.001	1.002	0.994	1.006	1.026	1.001	1.010
	ΔTEC	1.038	1.037	1.024	0.961	0.860	1.207	1.046	0.941	1.033	1.006	1.010
All commercial banks	ΔTFP	1.008	0.794	0.988	1.010	1.054	0.983	1.009	0.938	0.925	0.998	0.970
	ΔEFF	0.988	1.010	1.054	0.983	1.009	0.938	1.010	1.054	1.017	0.998	1.005
	ΔTEC	1.021	1.012	0.999	1.011	0.927	1.179	1.031	0.903	1.011	1.006	1.007

Note: ΔTFP denotes productivity change; ΔTFP > 1 and ΔTFP < 1 indicate positive and negative TFP changes, respectively. ΔEFF represents technical efficiency change; ΔEFF > 1 and ΔEFF < 1 show an improvement or decline in technical efficiency, respectively. ΔTEC is the technical change component, which measures how much the frontier shifts. It can be > 1 when the technical change is positive and < 1 when it is negative.

Source: Author's calculations

Section F.4

A comparison of banking efficiency across the regions

Aggregate efficiency of the banking sector excluding specialised banks at the regional level in Sri Lanka is presented in Table F.4.1. The highest levels of efficiency are found in the Western, Central and North Western regions while the Eastern, Uva and North Central regions recorded the poorest performances when the volume of advances and deposits is considered as the output of a bank's production in Model 1. The results for Model 2 show that three regions, namely Sabaragamuwa, Western and Central, are the most efficient in Sri Lanka, whereas the Eastern, North Central and Uva regions are found to be the least efficient in producing advances and numbers of deposits with given inputs. The Western region recorded higher efficiency in the production of advances and deposits with respect to both number and volume while the worst performance in the banking sector at the regional level is recorded by the Eastern region. These results are in line with the findings presented in Section 6.3 when both commercial and specialised banks are included in the sample.

Table F.4.1: Regional level aggregate efficiencies for the period 2011–2014

Region	Model 1			Model 2		
	Bias Corr. Estimates	Original Estimates	Rank	Bias Corr. Estimates	Original Estimates	Rank
Western	1.261	1.186	1	1.299	1.237	2
Central	1.569	1.460	3	1.310	1.282	3
Southern	1.851	1.688	5	1.350	1.299	5
Northern	1.776	1.694	6	1.359	1.315	6
Eastern	2.998	2.707	9	1.823	1.704	9
North Western	1.596	1.456	2	1.343	1.286	4
North Central	2.340	2.063	7	1.627	1.509	8
Uva	2.592	2.281	8	1.425	1.347	7
Sabaragamuwa	1.675	1.534	4	1.288	1.233	1
All	1.422	1.321		1.363	1.286	

Source: Author's calculations

In addition to the aggregate efficiency of banks across the regions, Table F.4.2 provides a measure of the significance of differences in aggregate efficiency between the regions. The Western region is used as the benchmark in this comparison. Banks' aggregate production efficiency of the other regions have been compared with the Western region. The results reveal that the aggregate efficiencies of all other regions are significantly lower than that of the Western region except for the Northern region with respect to Model1 which considers volume of advances and deposits as the output of a bank's production. However aggregate efficiencies for all of the regions are not significantly different from those of the Western region when efficiency is calculated by using the number of advances and deposits as the output of a bank's production. These findings are similar to the results presented inTable 6.5 in Section 5.3 when the sample is based on both commercial and specialised banks.

Table F.4.2: Comparison of aggregate regional banking efficiency based on the period 2011–2014.

Regional comparison	Model 1			Model 2		
	Bias Corr. RD Estimates	95% CI bounds		Bias Corr. RD Estimates	95% CI bounds	
		LB	UB		LB	UB
Central vs Western	1.243*	0.994	1.451	0.999	0.637	1.240
Southern vs Western	1.471***	1.238	1.701	1.032	0.711	1.251
Northern vs Western	1.402	0.639	1.800	1.039	0.593	1.293
Eastern vs Western	2.386***	1.750	2.924	1.398	0.872	1.755
North Western vs Western	1.268**	1.058	1.464	1.027	0.774	1.240
North Central vs Western	1.868***	1.462	2.249	1.249	0.808	1.559
Uva vs Western	2.069***	1.640	2.425	1.092	0.728	1.335
Sabaragamuwa vs Western	1.331*	0.971	1.586	0.985	0.684	1.190

Note: The coefficients with ***, ** and * indicate statistical significance from zero at the 1%, 5% and 10% levels, respectively; CI is confidence interval; LB is lower bound; UB is upper bound.

Source: Author's calculations

Regional determinants of banking efficiency

Regional determinants of commercial bank efficiency have been calculated in line with the analysis of regional level determinants presented in the section 6.4 for both commercial and specialised banks. As in section 6.4, efficiency scores have been used as the dependent variable to find the regional determinants of banking efficiency using two regression models. The first regression Model F.1(V) uses the efficiency scores derived when output is measured in monetary volume (i.e. output in Sri Lankan rupees) of advances and deposits as the dependent variable. In this model, V stands for the volume of advances and deposits used in deriving efficiency scores. The second regression Model F.2(N) uses efficiency scores derived when output is measured in number of advances and deposits as the dependent variable. In this Model, N stands for the number of advances and deposits used in deriving efficiency scores. The impact of the same set of variables on bank efficiency is tested by both Model F.1(V) and Model F.2(N). Table F.4.3 provides the coefficients of the environmental variables and their level of significance in the models.

According to the results presented in Table F.4.3 there is a significant positive relationship between bank performance and deposit density when efficiency is measured based on the volume of advances and deposits in Model F.1(V). This positive relationship is also observed when the analyses incorporated both commercial and specialised banks in section 6.4. However, the relationship is not significant when the sample is restricted to commercial banks only. Further, there is a significant and positive influence of all the variables on the performance of banks with respect to efficiency in producing number of advances and deposits based on Model F.2(N). These results are also similar with the results derived for all the banks in section 6.4. In conclusion, the regional

determinants of banking efficiency do not change substantially when the sample is restricted to the commercial banks only.

Table F.4.3: Determinants of regional level banking efficiency based on double-bootstrap regression models.

Variable	Model F.1(V)			Model F.2(N)		
	Estimates	95% CI bounds		Estimates	95% CI bounds	
		LB	UB		LB	UB
Constant	50.364	12.718	93.561	-3.354**	-5.265	-1.614
GDPPL	-2.490	-9.012	4.148	-1.688**	-2.240	-1.069
DENSIL	-1.609	-4.024	0.753	0.362**	0.085	0.620
DDENL	-4.489**	-7.708	-1.071	-2.049***	-2.438	-1.755
UNEMP	0.713	-0.112	1.706	0.550**	0.249	1.005
EDU	0.473	-0.487	1.027	0.126**	0.058	0.180
REG	-0.096	-0.419	0.284	-0.030	-0.102	0.045
TIME	0.699	-0.210	1.688	0.729***	0.594	0.865

Note: (1) The coefficients with *** and ** indicate statistical significance from zero at the 1% and 5% levels, respectively. GDPPL is the logarithm of regional per capita GDP; DENSIL is the logarithm of population density; DDENL is the logarithm of deposit density; UNEMP is the regional level unemployment rate; EDU is the percentage of the population with secondary level education in the region; BTYPE is a dummy variable for commercial and specialised banks; REG is a dummy variable for nine regions; TIME is a dummy variable for time trend; (2) The estimated confidence intervals are provided in Tables E.1 and E.2 in Appendix E.

Source: Author's calculations